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EUGENICS AND WAR[1]

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IN the midst of anxieties—national and personal—we meet to honor the memory of Sir Francis Galton, born on this day ninety-three years ago. "I take eugenics very seriously," he said, and we do him honor in following his example, and in considering what most closely concerns us at the present time in the light of what he regarded as of fundamental importance. So we naturally think to-night of war and eugenics.

I. The Dysgenic Tendencies of Modern War

In sailing along a coast of which we have no chart we can not tell from a distance whether this or that headland is continued into a dangerous reef or not, but we steer our course in reference to probable risks. Similarly, while we have practically no certainties in regard to the biological effect that a great war may have on a race, some probable risks are discernible. There are more than hints of dysgenic tendencies in modern war.

In ancient days a battle was probably in many cases a sifting out of the less strong, the less nimble, the less courageous on both sides, and the result of a war or raid was probably, in some cases, the practical elimination of the weaker of two clans. In both these ways there may have been a eugenic selection of the types best suited for times when fighting was the order of the day. But times have changed and war with them. Nation no longer exterminates nation, and victory is not necessarily with those of better physique. Moreover among the combatants on both sides the elimination is either indiscriminate, as when a battleship goes down, or in the wrong direction. The finest companies are set to the most hazardous tasks, where the mortality is often terrible,

[1] The Second Galton Lecture, delivered on February 16, 1915.

and the conspicuously brave are particularly liable to be killed. The point need not be labored: what Darwin said of even ancient times is true to-day:

> The bravest men, who were always willing to come to the front in war, and who freely risked their lives for others, would on an average perish in larger numbers than other men.

Our suspicion that war has a dysgenic influence grows when we think of countries with a voluntary system of military service. In the making of our armies there is a process of discriminate selection which works in the wrong way from the eugenic point of view. The call of their country attracts a larger proportion of the more chivalrous, the more virile, the more courageous. In the patriotic response not only in this country, but throughout the Empire, we are proud to recognize a multitude of men of character that is precious. We have to face the fact, of which we are socially proud, that Britain is sending to the battlefields large numbers of the best of her sons, whose early death would mean an impoverishment of the race. They will not all come home. Already one knows of many irreparable losses in fine families.

It is so important to avoid exaggeration that one wishes to hear the other side. It is pointed out quite justly that a large nucleus of genuinely brave men must stay at home to keep things going, and that they form a eugenic bulwark. This is true, but after gratefully allowing for these we can not shut our eyes to the large body of men of military age who can not fight or who will not fight, whose ranks, therefore, will not be thinned as those of the combatants are.

It is said again that elimination is confined to the men, so that the women remain, as they usually are, a eugenic safeguard. But they can not *directly* act in this way unless they have children, and it is to be feared that the war will seriously increase the disharmony already involved in the unwholesomely large number of unmarried women. Moreover we have only to think of the mothers in Belgium and Servia to see that the terrible sifting is not confined to the men. Severe and protracted war tends to lower physical vigor throughout wide circles of non-combatants; the maternal depression, like that induced by famine, tends to result in arrests of development and in the production of under-average types. We have no reason to believe that the germ-plasm is specifically affected, yet it is quite conceivable that very unfavorable nurtural conditions may induce prejudicial germinal variations of a heritable sort.

We are told that many join the ranks simply in a desire for adventure. This is very difficult to prove, but even if it be true, what then? The adventurous spirit is no bad thing, often implying, for instance, a healthy-minded lack of preoccupation with one's precious self. It is

granted at once that not all who are killed are the pick of our race, albeit they may be nobler in their death than many whose safety they have secured will ever be in their life, but is there any getting past the fact that we are exposing to abnormally great risks enormous bodies of men to whose composition there has gone a high proportion of the adventurous, the chivalrous, the virile, and the simply brave? The numbers must be borne in mind. When many brave unmarried soldiers are killed, we are justified in saying that the natural inheritance of the country is the poorer through the loss of many who should have enriched the next generation by more than their example. But this might mean relatively little to the stock if the proportion of combatants to non-combatants was small. It is far otherwise in the present instance. It is said that there are in Britain about 6,250,000 men between 18 and 45, 13.8 of the total population; if we have, as may be necessary, an army of three millions, that would mean almost every second man between 18 and 45. Even if it were every second man by lot, the thinning might mean only a terrible mortality, but if the fitter join the army in larger numbers and are thinned in larger proportions, war must be regarded as a dysgenic eliminator.

It is said that military training has such marked beneficial effects that it counterbalances many losses and disablements, and no one would deny the value of the drill, the discipline, the plain food, the regular hours and all that. But in the realm of life we can not make simple equations of this sort; non-transmissible modifications can not be pitted against innate qualities. Even supposing that all the modifications acquired in the training period are to the good, which they are not, we do not thereby lessen the loss to the natural inheritance of the race likely to be involved in the thinning of Lord Kitchener's army, which includes some of the best brains we have got.

There is another way in which the war is likely to have a dysgenic influence—by handicapping the more individuated. Many of the combatants will never return; many will be maimed and many enfeebled (in spite of the remarkably increased control of disease); but most, we hope, will come safely home. It is too much to expect, however, that they will find things as they left them. Everything promised will be done, we hope, but with the best will in the world things can not be as they were before. Hundreds of millions will have been spent unproductively and there will be need for many economies. This will select in the wrong direction, preventing marriage and so forth, for it will most affect the highly skilled whose work is of a kind that can be more or less readily dispensed with.

Eugenics and war—the clash between ideals and things as they are, is, perhaps, nowhere more terrible than here. For eugenics makes for the maintenance and improvement of the hereditary good qualities of

a race, while severe and protracted war makes for their impoverishment. There is rough sifting, and the meshes of the sieve are not eugenically determined. How far the impoverishment will go is hidden from us, how far it can be counteracted remains to be seen, and what pluses there are to set against the minuses is a question for careful consideration, but some degree of impoverishment is certain.

We are reminded, however, that the race does not live by the germplasm alone, and that war with its terrible sifting may be worth all it costs. But who can predict of any war what *all* its cost may be? In his famous essay on "The Moral Equivalent of War," William James said eloquently:

> Those ancestors, those efforts, those memories and legends, are the most ideal part of what we now own, a sacred, spiritual possession, worth more than all the blood poured out.

Perhaps it is so, especially if victory is thrown in! Already in Britain there has been a remarkable widening of sympathies, and waking up to the needs and interests of others.

Every one will agree that there are worse things than war—such as slavery, rottenness, softness, and dishonor; they are worse even than extinction. Let us admit that war may help "to preserve our ideals of hardihood," "to protect human nature against its weaker and more cowardly self," "to keep heroism and the martial virtues alive," and even to re-impress us with the imperativeness of eugenics, but in these concessions let us not admit that there are not tasks of peace capable of evoking and disciplining an equal hardihood and heroism. Let us not seek to conceal the fact that war, *biologically regarded,* means wastage and a reversal of eugenic or rational selection, since it prunes off a disproportionately large number of those whom the race can least afford to lose.

II. The Length and Breadth of the Struggle for Existence

Let us turn to another question, which concerns the struggle for existence. In spite of many protests, beginning with Darwin's, there is a widespread belief that Nature's message to man is: "Each for himself, and extinction take the hindmost," "contention is the vital force," careers are open to talons. There is indeed a measure of truth here, for we undoubtedly see much stern sifting in wild Nature, much redness of tooth and claw, extraordinary infantile and juvenile mortality, and, apart from parasitism, a ceaseless condemnation of the unlit lamp and the ungirt loin.

But when we look into matters more closely we find that we have not been careful enough either as regards Nature or Darwin's interpretation of it. For the struggle for existence, in and by which Nature

sifts, *i. e.,* eliminates discriminatively, includes much more than internecine competition between fellows of the same kith and kin. As Darwin said, the phrase is to be used "in a large and metaphorical sense, including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny." It may be that the struggle is most severe between members of the same or nearly related species, though Darwin did not give many examples of this, but, in any case, we must not generalize the story of the black and brown rat into a theory of life. The struggle for existence is often manifested in an endeavor after well-being. It is the clash that occurs whenever organisms do in any way assert themselves against limitations and difficulties. The answers-back may be competitive or non-competitive, self-regarding or other-regarding, with teeth and claws, or with wits and kindness. In face of overwhelming difficulties and thwarting limitations, one creature sharpens its weapons, another thickens its armor, a third gives its offspring a better send-off on the journey of life, and a fourth makes some experiment in state-socialism. The modes of reaction are many, and one never to be forgotten is that evasive change of habit and habitat which we call parasitism—the door to which is always open. The struggle for existence includes all the endeavors of mate for mate, of parent for offspring, of kin for kin, as well as every degree of self-assertiveness from the young cuckoo ousting the rightful tenant of the nest to the cannibalism in the cradle that occurs in the egg-capsules of the whelk.

It is said, however, that in the long run what counts is that some members of a varying species are fitter for the conditions of life than their neighbors, and therefore survive. This is true, but the eliminating clash is not necessarily between the individuals, the pruning shears are often in the hands of the environment. The survivor in a plague-stricken family does not survive at the expense of his kin, nor compete with his kin; his phagocytes parry the microbe. In lining its nest with two thousand feathers the long-tailed tit unmistakably strengthens its own and its family's foothold in the struggle for existence, but its reaction to environing difficulties does not hurt any other tit.

Two other points should be noted. The mode of the struggle for existence is not always competitive, and the result of the struggle for existence is not always the discriminate elimination of the relatively less fit to the conditions. Sometimes all that we can discern is a thinning —not a sifting—and that does not in itself make for evolution. The only result of the struggle for existence that necessarily makes for evolution—progressive or retrogressive—is discriminate selection, where the survivors survive in virtue of the possession of a particular character —which may be better weapons, stronger armor, swifter feet, greater

material success, or a more developed capacity for obeying the law of the jungle.

The other point is this. Darwin attached great importance to the web of life, to the manifold and subtle inter-relations that bind creatures together in a vibrating *systema Naturæ*. One of the reasons for his emphasis was simply that he was so good a naturalist; the other reason was his discernment that survival in the struggle for existence is definitely related to the already established system of linkages, to all sorts of interdependences and solidarities. The texture of the web of life is so fine that even an apparently trivial new quality may be vital to the situation. For man this is of the utmost importance, that selection has a definite reference to the established system of relations. In other words, man does to a large extent make his own sieves.

A broad survey of the realm of organisms shows that a very large proportion of time and energy is given over to activities which are not greatly, if at all, to the advantage of the individual. Borne on by impulses and instincts as imperious as hunger and thirst, how many animals spend themselves for their race. It is their meat and drink to do so, and Nature takes advantage of their capacity for self-forgetfulness. In some types it seems almost extreme, as Cresson says:

> Everything for the species; everything through the individual; nothing for the individual.

In Goethe's words,

> Nature holds a couple of draughts from the cup of love to be fair payment for the pains of a lifetime.

The continuance of the race is often very costly or even fatal to the parent, and there is exhaustion of energies in securing the safety and sustenance of the young. It is a great fact of Organic Nature that while competitive individualism pays up to a certain point, survival and success are also to those types in which the individual has been more or less subordinated to the welfare of the species. Part of their fitness is in being capable of self-sacrifice. This is part of Nature's strategy which man has not adequately appreciated.

Thus we can not accept the caricature of Nature as in a state of universal Hobbesian warfare, each against all, and no discharge for any. That is only one aspect of the struggle for existence, and the subordination of the individual to the species is another. Especially among the finer forms of life do we find that the answer-back which is given to the environing limitations is less and less frequently an intensification of competition, is more and more frequently something subtler, some parental sacrifice, some cooperative device, some experiment in sociality. The improbability of war being the saving grace of human history grows upon us.

To sum up, man is not bound to follow Nature, but if he does he is not shut up to an imitation of that mode of the struggle for existence in which rats excel, namely internecine competition. And if he does pursue this method, as in war, he can not console himself with the belief that the result will be the survival of the fittest in any desirable sense.

III. War, Biologically Considered, a Reversion to the Crudest Form of the Struggle for Existence

We have considered the fact that serious sustained international war, considered biologically, implies a reversal of rational selection, and we have discussed a widespread misunderstanding due to a narrow conception of the struggle for existence. Let us pass for a little to the proposition that war, biologically regarded, is a return to the most primitive and crude form of the struggle for existence. Looking at this great war socially, we are, as a nation, practically unanimous in the resolution to resist to the uttermost an outrage on civilization, and to stand with our allies at all costs for freedom and justice; we are proud of those who are fighting, enduring, and dying for their country; we know publicly and privately of the virtues to which the war has afforded opportunity among combatants and non-combatants alike. But, admitting all this and more, can we deny that war, biologically regarded, is a return to the rat versus rat mode of the struggle for existence? No escape seems possible.

If this unpalatable fact be true why mention it, since after a certain, or rather uncertain, date in history this war was inevitable? We mention it because it behoves us to mingle fear with our pride. The implied reversion brings with it terrible risks, and when we hold up our hands at the frightfulnesses committed by our enemies, we should remember that we are not exempt from the risk of slipping down the rungs of the steep ladder of evolution. In the actual environment of war, as Mr. Theodore Chambers said in his admirable lecture on "Eugenics and the War," "the decent garments of custom are often torn off," and the Berserk discovered; and for those who are not fighting there is also, and less excusably, a tendency to reversion because of our necessary preoccupation with a struggle which, though embellished with the latest scientific devices and illumined with the finest heroism, involves a recrudescence of primitive passion. We may already see the deterioration in ungenerous and inaccurate depreciation of German culture, in unworthy scares, in unkindness to aliens, in suggestions of barbarous reprisals, and so forth. On the whcle we are behaving well, yet it may not be amiss to remind ourselves of the solemn biological and psychological fact, that the past lives on in our present, with the risk of "Reversion ever dragging Evolution in the mud." What sowings

of dragons' teeth there must be in this terrible struggle; is it weakness to be afraid lest by and by, in the crop that springs from them, there be something worse than armed men?

IV. Some Practical Considerations

If the war is sifting out from the possible parent-stock of the future a larger proportion of those who are relatively more fit from an evolutionary or eugenic point of view, what is possible in the way of counteractive? Among the revaluations after the war may we not expect some change of public sentiment in regard to eugenic ideals, some more marked disapproval of selfish forms of celibacy, some more cordial encouragement of those desirable people who marry chivalrously while it is still springtime with them, without waiting till the bridegroom has secured twice the income his father had? There is patriotism in dying for our country; there is a conceivable patriotism in marrying for her and in bearing children for her.

It is to be hoped that one of the results of the terrible struggle in which we are engaged will be to direct more serious and widespread attention to the falling birthrate and the risks involved. We must insist on a discovery of the facts and causes of the decline in the British birthrate, and on a full discussion of the possibilities of checking the decline differentially. There is need for more plasticity in the ideal of "getting on," but it can hardly be regarded as a bad sign that there appears to be continual increase in the number of parents of good type who keep their families small because they do not wish their children —especially the girls—to run the risk of thwarted and unhappy lives. These risks have to be lessened, and that without making slackness feasible. In another connection we are all agreed that the lowering of the still far too high death-rate among healthy infants must continue.

As to the marriage of recruits, which has been a good deal discussed, other than biological considerations must be borne in mind, but the general eugenic position should be one of approval, if the ages are suitable, if the records are good, and if there is a certainty of adequate state-provision for the possible widows and children—the three large "ifs," it will be noticed.

If the wastage of war is brought vividly home to us by dramatic tragedies and irreparable losses, it may be that we shall be led as a nation to consider with increased seriousness and discernment other forms of vital wastage to which we tend to become blunted by familiarity. It should be interesting to inquire whether some of these, such as tuberculosis and alcoholism, are not, in part, at least, dysgenic in their sifting.

Galton hoped that in course of time eugenic principles would come to be dominant motives in the nation, but this is still far off. It is our

duty therefore to scan with careful criticism all practical proposals that may be hurriedly projected to meet crises of war strain. One instance may suffice. Unless the worst come to the worst, the nation should not consent to put children at the disposal of the farmer, for the effect of this would be to decrease the already too much restricted freedom of the child, and to depress still further the position of the agricultural laborer, for the needed improvement of which something would probably have been done ere now, had there not been war. Another danger, which may be mentioned, is that of permitting an interference with the liberty and dignity of women, which would not be tolerated in the case of men.

As eugenists we must resist in ourselves, and in all our organizations, the natural desire to economize in noble luxuries—in pictures and music, books and lectures, theaters and higher education. By all means let our criticism of consumption be intensified, but let it be enlightened. Let us prune our comforts before we pinch our souls. For apart from ourselves, who may be past praying for, economizing on the nobler luxuries means hardship and celibacy to those finer spirits who are the salt of the earth, whose virtue all must wish to see conserved in the natural inheritance of the race.

Without losing hold of the true idea and ideal of the state as a body politic—an organism—in which we all have our function, from cabinet ministers to road-members, we can not suppose that we are all equally irreplaceable. Indeed, the eye can not say unto the hand I have no need of thee, nor again, the head to the feet I have no need of you; but it will be agreed that true artists, for instance, are among the higher, less readily replaceable members of the community. There is no risk for us of there being too many of them. But there is great risk for them of there being too few of us to keep them and their art alive. The enforced economies of war imply lopping off super-necessaries; the danger is of crippling super-men. What has been said of artists applies also to the professions generally, and one recognizes the eugenic wisdom of the Professional Classes War Relief Council.

Those who have really learned the eugenic lesson are those who appreciate the organismal factor in evolution, who believe that the fundamental thing is the natural inheritance, bred in the bone. To those of this outlook it seldom seems promiseful to try to change by coercion what is intrinsic in the creature. The hopeful line is to make the most and the best of what we have, without tampering with that mainspring of life which is freedom. It is likely that we shall have many occasions for standing fast by this principle in the readjustments after the war. Attempts will be made to rush schemes which are non-eugenic in the sense of being coercive and incongruent with our racial temperament. One of these will be compulsory military training, of which

some wise men are advocates. It is probably less dangerous than a huge standing army, but it is full of risks. The mind takes color like the dyer's hand, and one fears that compulsory military training is one of the roots of militarism. It would be tragic to fall into the grip of one of the national diseases that we are combating in our enemies and to become insidiously Prussianized. Moreover the people of this country have an inherent dislike of coercion and do better without it. If a man does not demand our coat, we may perhaps give him our cloak; if he does not seek to compel us to go a mile, we may go twain without a grumble. Certain it is that in the time of revision it will be for the eugenist to champion the free and plastic organism rather than the highly efficient machine.

In recent years we have seen in this country a number of endeavors on a large scale towards the improvement of the conditions of human life. We have our detailed criticisms and honest doubts, but, on the whole, there is agreement that several things have been done, *e. g.*, in the way of Old-Age Pensions, which have greatly lightened the too prevalent "life-harming heaviness," and have relieved the national conscience at the same time. Other endeavors were in progress or incipient, which were more directly eugenic, in connection for instance with tuberculosis, and there was warrant for hoping that notable progress might be made along lines of practicable eugenics. Now there is the fear lest eugenic endeavors be put back for decades. Probably every one can already recall several progressive activities that have entered during the past six months into a state of encystation. For the undeniable privilege of being part of civilized Europe, and for the undeniable distinction of having been willing—on this occasion—to do the right thing at all costs, we shall have a long price to pay, and we shall be paying it long after the personal and ethical thrill has passed. Perhaps the deadliest part of the paying-up will be the shelving of eugenic endeavors and our connivance thereat.

The eugenic ideal is as old as mankind and older; it is the primeval pride in creation. But deliberate eugenics with the race as a whole in view is, with few exceptions, such as Plato's Republic and the Jewish people, relatively modern; indeed, Sir Francis Galton was the first to give it scientific expression. The newness of the idea of deliberate national eugenics, its remoteness from being instinctive, the rarity of the biological outlook, even among statesmen, make one apprehensive of the days of retrenchment. But this is not the time to bruit disappointment, and perhaps after all our fears may be liars.

Three hopeful considerations may be briefly referred to. (1) The war is likely to demonstrate the value of constitutions which can endure without stolidity, which have resiliency without "nerves." We may look forward to a heightening of the standard of all-round fitness.

There may also be a wholesome reaction from the two chief forms of national weakness, and an endeavor to improve the conditions which tend to increase these. All this will make for progress, as long as it is clearly recognized that veneering does not make bad wood sound. So far as improved nurture induces the fuller development of a good inheritance, or guards life from gratuitous infection or inhibition, or prevents the tare seeds in our inheritance from germinating, it is to be welcomed.

(2) In the second place this is a time of vivid national self-consciousness and of freshened idealism, and it is possible that the spiritual momentum of this may enable us to go ahead. It is just possible that we may be brought by the war nearer the idea and the actuality of a positive peace, of entering more fully into our kingdom. We must agree with Professor Patrick Geddes that the peace times we have known have often been more accurately states of latent war.

(3) A third consideration is also full of hope, that one of the almost certain results of the war will be an increased sense of solidarity among the various self-governing Dominions of the British Empire. We are going to know and to like one another better, having fought together, rejoiced and sorrowed together; we are going to see more of one another as distance-annihilating devices increase and cheapen. Perhaps we shall evolve a great confederate organization for the common tasks of peace. Is there not here a eugenic prospect of great interest, of larger experiments in out-breeding and in the influences of novel nurture? Perhaps we may discover in greater frequency of environmental and functional change, which is so potent in keeping the individual young, a possible source of variational stimuli, rejuvenating even the germ-plasm, which may be apt to get a little stodgy in one small island.

Perhaps we should not ever pass from a eugenic outlook without remembering that it is partial. In building a wall the mason uses plumb-line, level, and square, and so we have to employ other criteria besides that of the conservation and evolution of life. As eugenists we are concerned with the natural inheritance and its nurture, which is fundamental, as men we are also concerned with our social heritage, which is supreme. The social organizations and institutions in whose life we share, the traditions of honor, veracity and justice, the treasures of literature and art, memories, such as we honor to-night, which ever beckon us to follow after valor and understanding—these and much more form our social heritage, to be wrought for and fought for as keenly as the embodied health of the race. We cannot end without expressing the hope that even if the natural inheritance of our race must suffer impoverishment through the tragic sifting of this most terrible war, we shall win through in the end with our social heritage enriched.

BARBARISM, CULTURE, EMPIRE, UNION

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THE word "barbarism" voices the contempt of the Greeks for the peoples of other speech about them. Barbarian (βάρβαρος) is one of the words called onomatopoetic, whose sense is in its sound. It sounds like mere mouthing, and "bellower" or "inarticulate speaker" is its original sense. A barbarian meant to the Greeks one denied the main channel of human sympathy—the gift of comprehensible utterance. His language is pure babble. The word traces the undeveloped manners, customs, polity, trade, craftsmanship, art, science, religion, of rude communities back to mutual misunderstanding among their members. They are barbarians because unable to take each other's point of view. A custom is barbarous when it can not be followed without offending the sensibilities of others. A punishment is barbarous when its anguish to the victim would stay the executioner's hand were he really alive to it. Mr. Chesterton has just told us that the barbarian is he who "lacks that little mirror in the mind in which we see the mind of the other man"; or, to vary the phrase, "in which we see what the other man has a mind to."

The opposite of barbarism we call culture. Culture is the reflection within my mind of what my neighbor has a mind to. We owe the word to the Latins, who applied their term for "care" or "tillage" to that mellowed condition of the mental soil in which we come to feel things as other men have felt them. The culture of an individual is the whole body of the ideals he has absorbed from others. The culture of a nation, race or period is the sum and substance of the ideals transmitted from one individual to another until they have become the common property of all within its limits. It is in this collective sense that we speak of Swedish culture, Latin culture, the culture of the Renaissance. Civilization implies culture. The multiplication of common observances, common achievements, is impossible without mutual understanding, without tastes and aspirations shared. A civilization is a precipitate of all the ideals current among its citizens.

High civilization tends to confirm what it leaves of man's native barbarism. The argument "Our ways are good; therefore no other ways are worth notice" is a non-sequitur dear to the human mind. The legendary order of Caliph Omar for the destruction of the Alexandrian Library bespoke culture and barbarism at once: "If these books con-

firm the Koran, they need not be preserved; if they oppose the Koran, they should not be preserved." The Greeks called Egyptians, Latins, Hebrews, Hindus, alike barbarians, and disclosed their own barbarism in so doing. The Jews were to Jews the chosen people of God. To the Chinese the Chinese alone are Celestials. To us of the United States our own land alone is God's country. The possession of these lofty and complex ideals but emphasizes the inability of their possessors to transcend them.

Barbarism may be either naïve or conscious. Incapacity to share in the desires of others may be betrayed either by ignoring them or by aiming to thwart them. We associate the attitude of indifference with the lower animals, and call it brutal; the attitude of frowardness with evil spirits, and call it devilish. The one betokens vacuity of mind, the other perversity of heart.

Beyond both indifference and frowardness, but barbaric like both, stands the spirit of empire; the impulse to impose my will, irrespective of what I will, upon others, irrespective of what they will. This attitude of mind is barbaric, for it reveals my inability to take to heart what others have at heart; but it is more than brutal barbarism, for it takes the wills of others into account; and it is more also than devilish barbarism, for it builds my own will as well as destroys theirs. It is neither dumb, like animal selfishness, nor is it outspoken in the words of Mephistopheles: "I am the spirit that denies;" but in the words of Napoleon: "I was born to bend the wills of other men to mine." The instinct of empire is a social attitude in its external recognition of others; it is unsocial, in failing to make that recognition an inward fact.

Such an external recognition of another's purposes is compatible, be it said, with unlimited instruction concerning them. For all intellectual apprehension of taste is knowledge about it; we must feel in order to know taste itself. The external attitude is even fostered by instruction; since knowing so much we may easily fancy we know all. We become pedants of culture, mistaking its cognitive shell for its sensitive kernel. However rich our information concerning the ideals of another, unless in some degree we share them, our culture as far as he is concerned is nil. Looking on without taking part, perceiving without experiencing, we remain essentially barbarian.

Culture, the actual assimilation of the ideals of other people, replaces the spirit of empire by a spirit which may be called that of union. The spirit of empire is a simple intention, namely, the establishment of my will, because mine, in place of other wills, because other than mine. The spirit of union proves to contain a triple intention. The penetration of another mind has three effects upon mine: the awakening of certain desires of the other in me, the missing of

certain of my desires in him, and the recognition of a conflict between certain of my desires and certain of his. The spirit of union thus engenders three purposes: a purpose to partake in admirations, a purpose to impart them, a purpose to reconcile them. Were two minds in perfect union, each would be leader in the pursuit of its own independent purposes, each a cordial second to the independent purposes of the other, and each ready to settle their conflicts of purpose by any means which a sympathetic understanding of the purposes of the other would sanction, and only by such means. So a Christian and a Buddhist, had each a sympathetic grasp of the other's faith, might seek, the one to give, the other to receive, that joy in the Lord which Buddhism has lacked, and that interest in the fate of the whole animate creation which historical Christianity has lacked. So Russia, China and Mongolia, were the mind of each open to the mind of the others—a supposition still extravagant between any peoples—might weigh between them the question whether in the interest of all three Mongolia should remain under Chinese suzerainty, accept Russian rule, or become autonomous.

The spirit of union does not exclude the possibility that the end of a discussion between the parties may be disagreement, and change them from co-workers into opponents. But opponents each responsive to the interests of the other would fight, not for their own interests solely, but for what each believed to be the interests of both. This alone is righteous war. The saying of Benjamin Franklin: "There never was a good war or a bad peace"—was a pardonable exaggeration; but we make it a falsehood when we interpret it to mean that there never can be a good war or a bad peace. The spirit of union, which is the spirit of good will, aims at peace, but only in the interest of all; and may inexorably demand war, also in the interest of all.

To the lasting honor of this nation, the United States have been the first to enter into treaties embodying this third requisite of cultivated relations with other peoples. However infrequent the use of such machinery of discussion in advance of war, it will not rust ingloriously, for it is made of a metal that rust can not corrupt. No other machinery, thanks to man's inventiveness, is needed to-day by the spirit of union. The freedom of intercourse between nations of the modern world in itself provides for the satisfaction of the two other impulses which make up the spirit of union—the impulse to offer to others our share, and to gain from them their share in the world's ideals.

To which of these two spirits—empire, or union—does the future belong? To the spirit of union, for a reason partly psychological and partly mathematical. Conquests unite the conquered against the conqueror; and combinations tend to be stronger than individuals. Minds being what they are and numbers being what they are, a man is apt

to avail more through his friends than through his own right arm. The clasp of the hand will outlive the blow; for there is the strength of two behind every grasp, and of but one behind any blow that evokes it.

A play on French words may serve to fix in mind the necessary evanescence of empire. We may fancy that the word derives from the verb *empirer,* signifying to deteriorate. By this burlesque etymology its root-meaning comes to be that of going from bad to worse; and an empire becomes accordingly that form of international organization which is foredoomed to decline and fall.

Even the short span of years which recorded history has yet covered brings ample evidence in support of this definition. Either external coalitions to overthrow them or internal coalitions to reject their yoke have ended, or threaten to end, nearly every known empire. The British Empire which still stands and even shows signs of permanence, has learned the lesson of union, and bids fair to become an empire in its name alone. British imperialism was once, as Professor Cramb has told us, the will to give all men under British sway an English mind, in the spirit of the boast of Alexander the Great: "I will make all men Hellenes." But the instruction of England in the larger art of government, begun in North America, has been continued since, and her imperial aim is fast becoming a will to live with other men and let them live. The British Empire, if it last, will one day be what the Seven Seas choose to make of it, not what England alone chooses to make of it. The Irish mind, the Boer mind, the Hindu mind, will share with others in the process. The United States have of late been tempted to forget the lesson they themselves taught; but Cuba, Mexico and the Philippines stand as witnesses that for all our growth in power, we still hold fast to the doctrines of our Declaration of Independence. With a giant's strength we have twice and even thrice refused to use it like a giant. Born a Union, we are engaged in laying the foundations of other unions. It is possible to conceive of but one more august political structure than these—one in which every sovereign people in the world should contribute each its own mind to a union which should ensure the perpetual development of the minds of all.

The conclusion of the whole matter may be put into modern American. Empire is the child of the barbarism out of which the world tends; culture the parent of the union into which the world tends. There is no middle term; for it is always barbarism to claim "I am It"; and culture always answers: "There are others."

MEASURING HEAT FROM STARS

By Dr. W. W. COBLENTZ

I. Some Questions Answered

IF the title of this paper had been chosen as, "Measuring Heat from Stars—Of What Practical Use Is It Anyway?" it would express the feeling of the average interviewer. The question is not meant to be contemptuous. It is the expression of the mind that figures everything on the basis of an immediate return upon his investment.

The interrogator may be one "engaged in writing an article for some magazine" and he must needs "tell the layman the practical side of the subject." Suppose I, in turn, ask my interrogator the question: "Of what prospective use was your layman when he was in the first stages of development?" Said interrogator shrugs his shoulders, smiles, and admits that perhaps the "layman" is not the only one to be considered; that some of the results of investigations must go into the great storehouse of knowledge, no one knowing what their ultimate use may be; that the great unknown can be explored only step by step; that each achievement may be only one more link in the chain of knowledge, perhaps to be disputed and refuted by some future investigator or perhaps be put to some practical use of some future "layman."

Another question raised is, "Why the Government should be measuring the heat of stars?" not realizing that such activities are incidental, conducted to assist, if possible, its citizens in every possible way. The narrow-gauge college professor may perhaps take it as an intrusion upon his field. To such an one the writer can but tell the lesson taught him some months ago, when one bright morning, on walking through the woods, a loud commotion was heard in the topmost branches of a tall oak tree. Two wood-peewees were quarreling for the possession of this tree—as a place to catch flies! There were hundreds of other trees close by, then why quarrel about this one. How like the scientific man, I thought. We quarrel for fields of research, just as though the heavens were not ablaze with objects for investigation.

A further question asked by the interrogator is, "Well, how do you measure the *temperature* of the stars?" This question may be easily dismissed by saying that we can not measure the temperature of the stars. The best we can do is to attempt to measure the rate at which they are losing heat. But until the past summer even this attempt was of little interest to the astronomer. Heretofore experimenters were glad to be able to record heat from a few of the brightest stars; let alone attempting to measure stars of the 6.7th magnitude which are about

1/480th as bright. This is not saying that previous attempts were of no avail; for they were the stepping stones which aided in what small success was attained with the Crossley reflector on Mt. Hamilton, this past August. If, then, the "layman" with his question of the practical side will please wait a little while longer, and in the meantime consider that the present work is simply another stepping stone in the path of conquest of the secrets held in the firmament, it will greatly help the investigators who are not concerned with the immediate commercialization of everything in and under the heavens.

II. A Brief Summary of Previous Attempts at Measuring Stellar Radiation

The measurement of stellar radiation has been attemptel by three methods: (1) by means of thermoelements, (2) by means of a Nichols radiometer, and (3) by means of a selenium cell.

Among the earliest attempts by means of thermoelements are the measurements of Huggins.[2] He used one or two pairs of elements of bismuth-antimony in the focus of a refractor having an aperture eight inches in diameter. He recorded positive deflections for *Sirius, Pollux, Regulus,* and *Arcturus.* The data given are very meager. It required from four to five minutes (fifteen minutes in one record) to obtain a reading.

Thermoelectric measurements of the radiation from *Arcturus* and *Vega* were made by Stone[3] who used a refractor 12.75 inches in diameter. In spite of the excessively long time (about ten minutes) required to obtain a reading he appears to have obtained fairly reliable results. His measurements show that *Arcturus* emits more radiation than does *Vega;* his numerical measurements for June 25, 1869, being *Arcturus: Vega* = 3 : 2. Considering the fact that the infrared radiations from *Arcturus* suffer greater absorption than those of *Vega* in passing through an air mass highly saturated with water vapor, and in passing through the glass lenses of the refractor this ratio (3/2) is in close agreement with subsequent measurements using a reflecting telescope.

Recent measurements of stellar radiation were made by Pfund,[4] using thermoelements in an evacuated receptacle. The receivers attached to the junctions of the bismuth alloys (BiSn—BiSb) were about 1.2 mm. in diameter. The sensitivity was such that the radiation from a Hefner lamp at a distance of 1 m. gave a deflection of 2400 mm. He used a reflecting telescope thirty inches in diameter, and made measurements on *Vega* (7.5 mm. deflection), *Jupiter* (part of disk; 3 mm.), and *Altair* (2.0 mm. deflection, sky hazy). The ratio of the radiations

[2] Huggins, *Proc. Roy. Soc.,* 17, p. 309, 1868–9.

[3] Stone, *Proc. Roy. Soc.,* 18, 159, 1869–70.

[4] Pfund, *Publ. Allegheny Obs.,* 3, p. 43, 1913.

Vega: Altair = 3 : 7, which is at variance with the results obtained on Mt. Hamilton, and emphasizes the importance of making observations through an atmosphere free from water vapor. He concluded that with a more sensitive galvanometer and one of the largest reflectors it would be possible to observe stars to the fourth magnitude.

An extensive series of measurements of the radiation from *Arcturus, Vega, Jupiter* and *Saturn* were made by Nichols[5] by means of his radiometer, which, like the thermopile, absorbs all the radiations of all wave-lengths falling upon it. The receivers were 2 mm. in diameter. A candle at a distance of 1 m. would have given a deflection of 724 mm. He used a two-foot reflector and observed deflections of 1 to 2 mm. The sensitivity of his radiometer was such that a deflection of 1 mm. would be caused by 1/68,750,000 of the heat received on a surface equal to the aperture of the concave mirror from a candle at 1 meter distant. Or, neglecting atmospheric absorption, the sensitivity was such that by using the two-foot mirror to focus an image of the flame upon the radiometer, he would have obtained a deflection of 1 mm. from the candle placed at a distance of 5 miles. He concluded that the thermal intensity was *Vega: Arcturus: Jupiter: Saturn* = 1 : 2.2 : 4.7 : 0.74. As for the possibility of further work he concluded that by using a five-foot reflector it would be possible to observe white stars down to the second magnitude and red stars possibly to the third magnitude.

The Boys[6] radiomicrometer has also been tried in measuring radiation from stars. The instrument was used with a sixteen-inch reflecting telescope. The slight deflections obtained on various planets and stars were regarded as of questionable origin.

The earliest measurements of the light from stars by means of a selenium cell were made by Minchin,[7] who used a 2-foot reflector. He examined about a dozen stars, some being as small as the third magnitude. Owing to the peculiar properties of the selenium cell, which is highly selective in its response to radiations of different wave-lengths, the data can not be used in comparing the radiation from different stars. The selenium cell can be applied, however, in the measurement of the maximum and minimum of light emission from a variable star which does not change in color. For this purpose it has been used by Stebbins[8] in connection with a 12-inch refractor.

III. A Brief Account of the Present Measurements of Stellar Radiation.

The telescope used in the present investigation was the well known Crossley Reflector which is part of the equipment of the Lick Observa-

[5] Nichols, *Astrophys. Jr.*, 13, p. 101, 1901.

[6] Boys, *Proc. Roy. Soc.*, 47, p. 480, 1890.

[7] Minchin, *Proc. Roy. Soc.*, 58, p. 142, 1895; 59, p. 231, 1896.

[8] Stebbins, *Astrophys. Jour.*, 32, 185, 1910; 33, 385, 1911.

tory at Mt. Hamilton, California. The reflecting mirror is three feet in diameter. The altitude of the station is a little over 4,000 feet. The summer months being rainless; there being no fog or dew; the night temperature being only a few degrees lower than the day time—these were items which made it possible to have fairly uniform conditions on different nights.

The radiometers used in these measurements were minute thermocouples with receivers 0.3 to 0.4 millimeter in diameter; *i. e.*, about as large as the punctuation mark at the end of this sentence. These thermocouples, the elements of which were bismuth and platinum, were mounted in glass receptacles, as shown in Fig. 1, from which the air could be evacuated. The vacuum was then maintained by occasionally heating metallic calcium, *Ca*, contained in a quartz-glass tube shown in Fig. 1. Metallic calcium has the property of absorbing atmospheric

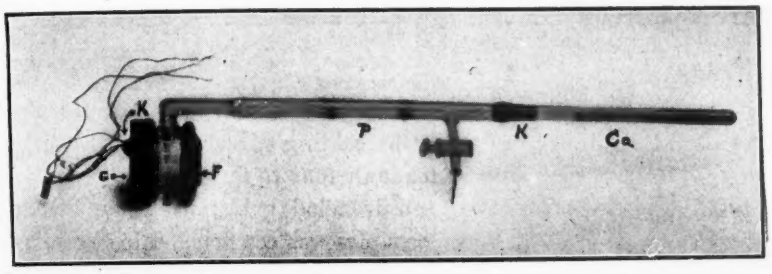

FIG. 1. SHOWING THE GLASS RECEPTACLE WHICH CONTAINS THE THERMOCOUPLES, *E*, AND THE CALCIUM *Ca* USED TO MAINTAIN A VACUUM.

gases when warmed to a low red heat. This glass receptacle was then mounted in a brass box as shown in Fig. 2, which was made especially to take the place of the plate-holder in the camera which is part of the equipment of the telescope. By removing the screws *S, S*, it was therefore a matter of only a few minutes to dismount this radiometric outfit and substitute the plate-holder. In this manner part of the night was spent in making radiometric measurements on stars, after which the telescope was surrendered to another observer who was photographing a newly discovered satellite of Jupiter.

Referring to Fig. 1, it may be added that the star light after reflection from the telescope mirror passes through a fluorite window, *F*, and is brought to focus upon the receiver, *E*, of the thermocouple where the rays are absorbed thus heating the thermojunction. This extremely minute amount of heat is sufficient to warm the thermojunction a few hundred-thousandths of a degree and thus generate an electric current which passes through the coils of a miniature tangent galvanometer, shown in Fig. 3. Unfortunately one sees nothing of these coils of wire which are imbedded in two blocks of Swedish iron.

Because of its high magnetic permeability, iron is used to shield the suspended system of magnets from variations in the magnetic field, such as produced by passing street cars, etc. This galvanometer is very sensitive, so that it responds to a current of less than one ten-billionth

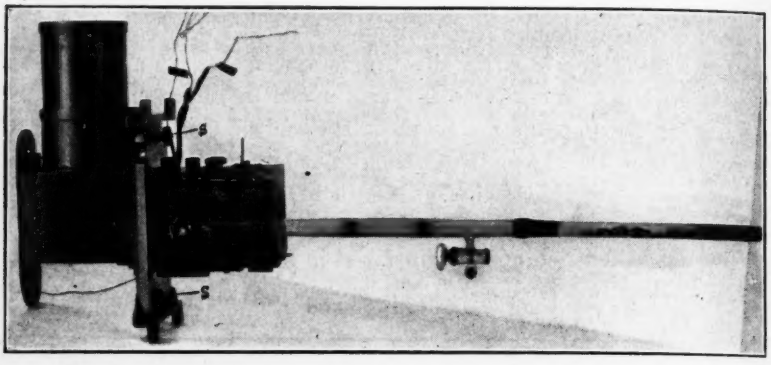

FIG. 2. SHOWING THE GLASS RECEPTACLE OF FIG. 1 MOUNTED BY MEANS OF THE SCREWS *S, S,* IN THE PLATEHOLDER OF THE CROSSLEY REFLECTOR.

of an ampere, and in observing the heating effect produced by different stars, measurements could be made in four to five seconds.

This outfit consisting of an ironclad galvanometer and two receptacles containing the thermocouples was constructed in Washington, D. C., and carried to Mt. Hamilton, Calif., a distance of over 3,200 miles without serious mishap (one thermocouple was broken in climbing the mountain). A vacuum pump was shipped, but it was not unpacked. The slight vapors given off from the cement and stop-cock grease were removed from these receptables by occasionally heating the calcium by means of a small alcohol blast lamp. From this it is evident that one of the principal achievements was in demonstrating that with an equipment of several thermoelements, mounted in evacuated receptacles, one can go to the remotest station for radiation measurements, without taking an expensive or cumbersome vacuum pump.

After observing for several nights it was found that red stars emitted far more radiation than do the blue ones having the same photometric brightness, and attention was given mainly to the solution of this question. Accordingly stars were selected having the same visual magnitude, but differing in color; and which were close together in right ascension and zenith distance, in order to obtain the measurements of the ways traversing the same air mass. In passing through our atmosphere, the radiations from the red stars suffer a greater absorption than do the blue stars. For this reason it was desirable to eliminate, as much as was possible, the effect of air mass.

As the work progressed, it became a rather instinctive feeling to

avoid the blue stars of less than the fourth magnitude, owing to the difficulty in measuring their radiations. However it was found possible to measure the heating effect of red stars down to the 6.7 magnitude.

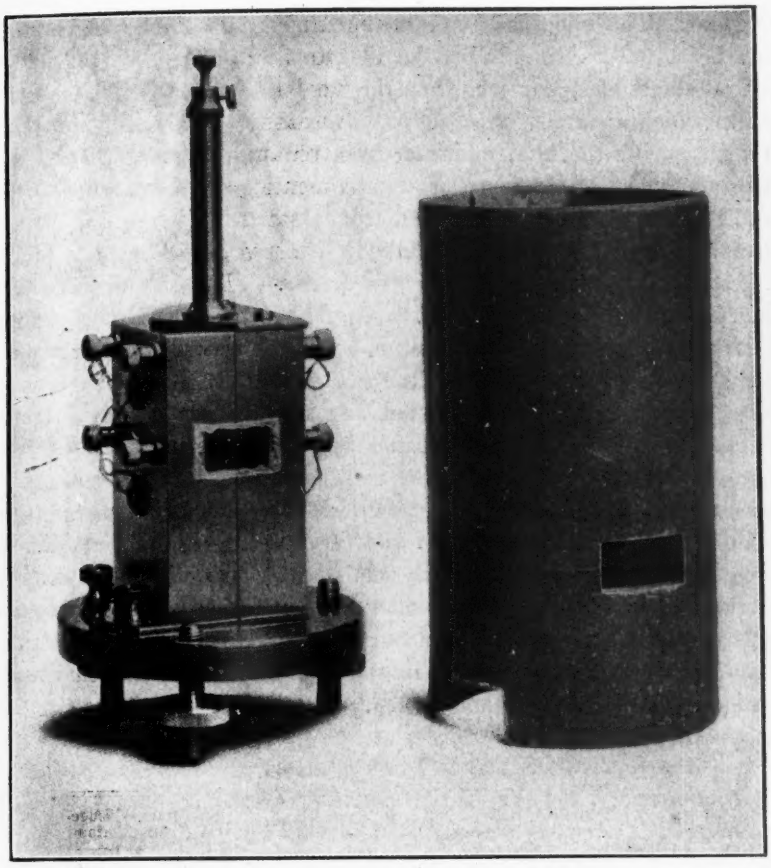

FIG. 3. IRONCLAD THOMSON GALVANOMETER USED IN MEASURING THE ELECTRIC CURRENT GENERATED BY THE THERMOCOUPLES. One of the iron shields is shown to the right.

If it had been merely an attempt to show the possibilities of the instruments, then by selecting red stars, and by increasing the galvanometer sensitivity, positive indications could have been obtained of radiation from stars of the eighth to ninth magnitude. That, however, would have been simply a spectacular achievement, to awe the layman, and under the present conditions of observation, could not contribute much to science.

The aim was to do one thing thoroughly, rather than to attempt a varied program. This one thing was the establishment beyond all reasonable doubt, by two distinct methods, that the red stars as a

class emit a far greater amount of total radiation than do the blue stars; that they have a higher emissivity, or, in other words, that they are cooling faster than the blue stars. (In parenthesis it may be added that it is doubtful whether the interior of a red star is cooler than a blue star. The whole mass is no doubt shrinking and the temperature may be actually rising. But the idea to be conveyed is that in the various stages of stellar evolution, the "red star stage" seems to be the one in which a star is "burning out" the fastest.) The first method, viz., measuring the total radiation from red and blue stars having the same photometric brightness, as already mentioned, is somewhat uncertain, because the radiation received from a star is a function of its size, distance, temperature and especially its emissive power. Some of the largest stars are no doubt the farthest from us. The second method of observation consisted in roughly separating the star's rays into a spectrum, by means of an absorption cell of water which absorbs most of the infra-red rays and transmits the visible rays. Hence, by measuring the total radiation from a star, and also the part which is transmitted by the absorption cell of water we obtain an estimate of the relative amounts of energy in these two parts of the spectrum. This measurement is a ratio of two quantities of energy; and hence is independent of the size, the distance and the temperature of the star. It gives us direct information of the emissivity of the different parts of the star's spectrum. It is true that it gives us information of only two parts of the spectrum; but, from our knowledge of the solar spectrum, and of the spectra of terrestrial substances, this information enables us to make important deductions as regards the distribution of energy in the spectra of stars.

TABLE I

Object	Magnitude	Deflection	Type	Object	Magnitude	Deflection	Type
β Orionis	0.34	2.50[1]	*B*8 p.	19 Piscium	5.30	0.46	*N*
α Orionis	0.92	22.4	*Ma*	γ Aquarii	3.97	0.24	*A*
θ^2 Tauri	3.62	0.18	*A*5	λ Aquarii	3.84	1.02	*Ma*
ϵ Tauri	3.63	0.35	*K*	δ Capricorni	2.98	0.28	*A*5
ν Tauri	3.94	0.12	*A*	β Aquarii	3.07	0.55	*G*
γ Tauri	3.86	0.36	*G*	β Ophiuchi	2.94	0.37	*K*
δ Tauri	3.93	0.52	*K*	δ Ophiuchi	3.03	1.37	*Ma*
α Auriga	0.21	6.14	*G*	α Coronæ Borealis	2.32	0.48	*A*
α Tauri	1.06	6.78	*K*5	γ Draconis	2.42	1.59	*K*5
		6.84		β Ursæ Majoris	2.44	0.37	*A*
δ Ceti	4.04	0.08	*B*2	γ Draconis	2.42	1.58	*K*5
υ Ceti	4.18	0.31	*Ma*			1.67	
φ Pegasi	5.23	0.22	*Ma*			1.64	

Some of the data obtained by measuring the total radiation from blue and from red stars, having the same brightness, will now be discussed. It was possible to make quantitative measurements on stars

[1] Galv. Sensitivity $i = 1 \times 10^{-10}$ Amp.

down to the 5.3 magnitude. It is to be remembered, in considering this data, that a star of say the second magnitude is only $\frac{1}{2.5}$ as bright as a star of the first magnitude, *i. e.*, one magnitude differs from another by the factor 2.5 in brightness. However the total radiation may be entirely different as may be noticed in Table I. In this table the last column gives the spectral classification used by astronomers. The blue stars have the classification *B, A.* These stars pass into the yellow gradation *F, G, K,* the latter being yellowish-red. The red stars are Class *M* and the deep red ones are Class *N.* Keeping in mind this classification, it may be noticed that the red star *α Orionis* emits about eight times as much total radiation as the blue star, *β Orionis,* which is much brighter to the eye. A similar example is the yellow star *α Auriga* (Capella) and the beautiful red star, *α Tauri* (Aldebaran), both of which stars are familiar objects. The latter is only about one-half as bright to the eye; and yet it emits the same amount of total radiation as does the brighter star. Comparing stars of the same photometric brightness the 5.3-magnitude stars *φ Pegasi* and *19 Piscium* are interesting examples because of their smallness, and because the latter is of a deep red color. The latter follows the general rule that the redder the star the greater the amount of total radiation received. The number of these very red stars is very small and they were not conveniently situated for observation. However from the observations on numerous stars of *Class M* as compared with blue and yellow stars of the same photometric magnitude, it is to be expected that these very red stars, *Class N,* will be found to have, as a general rule, the highest emissivity of all. Among all the data collected, on 105 stars, there are no exceptions to the general classification, viz., the redder the star the greater the amount of total radiation emitted. To some, of course, this information is not unexpected. However, if the reader will pause for a moment and consider that some of these measurements were made on starlight which left its source more than 160 years ago, and that stellar distances are so inconceivably great that another 160 years must elapse before the arrival of starlight which is being emitted at the present moment, it will be evident that every measurement has a value of far greater importance than merely confirming our expectations which are based upon our preconceived notions of what is occurring on a star and in passing through interstellar space.

The second method of studying the quality of the radiations of red and of blue stars, by means of the absorption cell of water, is more limited in range, because of the weakness of the radiations received. Only a few stars could therefore be investigated by this method. From the first method of observation it is to be expected that the total radiation from a red star contains more infra-red rays than does the total radiation from a blue star, and hence the amount transmitted by the

TABLE II

TRANSMISSION OF STELLAR RADIAITION THROUGH A 1 CM. LAYER OF WATER

Object	Stellar Class	Transmission in Per Cent.	Remarks
		Blue Stars	
α Lyræ	*A*	58	(Vega)
α Aquilæ	*A*5	69	(Altair)
β Orionis	*B*8 p.	42	(Rigel) A low value for a blue star
		Yellow Stars	
α Auriga	*G*	48	(Capella)
α Boötis	*K*	45	(Arcturus)
α Tauri	*K*5	35	(Aldebaran)
γ Draconis	*K*5	32	
		Red Stars	
β Pegasi	*Mb*	29	
α Orionis	*Ma*	27	(Betelgeux)
α Scorpii	*Ma* p.	27	(Antares)
α Herculis	*Mb*	21	
Jupiter		65	Receiver in center of disk including part of dark band.
		66	Receiver covers upper dark band.
Venus		59	
Saturn		55	Receiver covers central disk.
Moon		14.7	

water cell will be less for the red star, *Class M*, than for the yellow star, *Class F, G, K*, and a blue star, *Class B, A*. This is the true condition of affairs, as may be noticed in Table II., which gives the percentage of the total energy falling upon the thermocouple, which is transmitted by the water-cell, for blue, yellow and red stars. From this table it may be seen that as much as 60 per cent. of all the radiations coming from a blue star lies in the spectral region to which the eye is sensitive, while only from 20 to 30 per cent. of the total radiation received from a red star affects the eye and the photographic plate. This brings out very clearly why it is that a red star of the same visual brightness as a blue star (causes a larger galvanometer deflection) emits from two to three times as much total radiation. It means that from 70 to 80 per cent. of the radiation from a red star lies in the infra-red—beyond the spectral region to which our eyes are sensitive.

The absorption cell tells us nothing of the size or the distance of the star. It indicates that the shape of the spectral energy curve of the star is such that only about one fourth of the total energy emitted by a red star lies in the visible and in the ultraviolet part of the spectrum. However, it should dispel all doubt as to the quality of the radiations emitted by red and by blue stars. The absorption does more than merely tell us the region of the spectrum in which the most energy is distributed. It may prove useful in detecting dark companions of

star systems. There are no doubt many blue and yellow stars having companions which have become so cool and nonluminous that their presence can not be detected photographically. To the eye the star will appear to be blue or yellow. A good illustration is the ordinary paraffin candle. To the eye it looks yellow, because the red-hot wick contributes but little to the total luminous output. But the red-hot wick is very rich in infra-red radiations, as compared with the luminous flame, and when measured with a thermopile (or some other similar radiometer), and an absorption cell, it is found that the red-hot wick contributes materially to the total energy radiated from the flame. In a similar manner a red-hot star will contribute materially to the total radiation from a star system which appears to be blue. The conspicuous star *β Orionis* (Rigel) is an excellent illustration. Astronomers have classified it "*B 8 p*" the letter "*p*" meaning that it has a peculiar spectrum. Whether this peculiarity is sufficiently definite to indicate that there is a companion star, the writer does not know. However, the writer's radiometric classification, Table II., would place it with the yellowish-red stars having a transmission of some 40 per cent. through the absorption cell, instead of with the blue stars. No doubt this star has a dark companion which has thus far escaped detection.

An excellent example which the writer desired to study, but was prevented owing to the fact that at that time (August, 1914) the star does not rise before dawn, is *Sirius*. This star has a companion which has become so cool that it is rated as a tenth-magnitude star. Although the presence of a companion star was suspected, the light coming from it is so weak that in the presence of the bright star (Sirius), for some years, it defied detection. This companion star is of enormous size, being one half as massive as the bright component; but it sends out only 1/30,000 as much light. It would have been very interesting to determine what amount of radiation from this star system is transmitted through the water cell.

Two stars having 5th magnitude companions were studied, viz., *β Pegasi* and *α Herculis*. Both stars appeared to have an excessive amount of total radiation in comparison with their photometric brightness. In the case of *α Herculis* the companion star caused a deflection of almost a centimeter on the galvanometer scale. In Table II. it will be noticed that this star has the lowest transmission through the water cell. No doubt this is attributable to the large amount of infra-red radiations contributed by the companion star, which caused galvanometer deflections about ⅕ those obtained from the bright component.

Attention has already been called to the fact that the receiver, which was attached to the thermojunction, was very small. It was therefore possible to measure the radiations from different parts of the surface of

a planet. One of the most interesting series of measurements was made on the light reflected from the bright and the dark bands of *Jupiter*. Both gave practically the same transmission through the water cell, showing that whatever may be the cause of these dark bands, the diminution in brightness is quite non-selective as regards the infra-red. Interesting measurements were made on *Saturn* and its rings. Measurements on a planetary nebula showed no positive indications of radiations from it. However, from the observations on blue and red stars, it was not expected that definite indications would be obtained of radiations from a nebula.

In marked contrast with *Venus, Jupiter* and *Saturn,* only about 15 per cent. of the light reflected from the Moon is transmitted by the water cell. This is attributable to the fact that the Moon having no atmosphere, the surface becomes warm from exposure to the Sun's rays, and in turn radiates heat waves, which are not transmitted by the absorption cell of water.

In view of the fact that, heretofore, observers were glad to obtain any indication of the radiation from stars and planets, it is of interest to record that in observing the radiation from *Venus* it was necessary to place a resistance of 50 ohms in series with the galvanometer in order to reduce the sensitivity and thus keep the galvanometer deflection (which amounted to 127 cm.) upon the scale.

IV. The Absolute Value of the Total Radiation from the Stars

It is of interest to obtain a rough estimate of the total amount of heat received from a star as compared with the heat received from the sun, which is of the order of 1.9 gram calories per square centimeter per minute. This was accomplished by standardizing the thermocouples and galvanometer in terms of radiant power. In this way it was determined that the amount of starlight which caused a deflection of 1 mm. $= 34 \times 10^{-14}$ gram calorie per sq. cm. per minute. Or it would take 100,000,000,000,000/34 minutes, *i. e.,* six million years to raise the temperature of 1 gram of water 1° C. The star *Polaris* is an excellent example. It produced a galvanometer deflection of 6 mm. Hence it would require only one sixth as long to raise the temperature of 1 gram of water 1° C. In other words, assuming that, in the meantime, all the incoming radiations are absorbed and that no heat is lost by conduction, convection or radiation, then it will require the radiations from *Polaris* to fall upon 1 square centimeter continuously for one million years in order to raise the temperature of 1 gram of water 1° C. In marked contrast with this value, the radiation from the sun which is transmitted by our atmosphere and falls upon an area of 1 sq. cm. of the earth's surface is sufficient to raise the temperature of 1 gram of water 1° C. in about one minute. Moreover, the total radiation

from all the stars which at any moment can fall upon 1 sq. cm. of the earth's surface is so small that it would have to be absorbed and conserved continuously for a period of 100 to 200 years in order to raise the temperature of 1 gram of water 1 degree centigrade. Evidently the incoming stellar radiation can contribute but little in retarding the cooling of the earth. For the measurements of nocturnal radiation, which is usually a loss of terrestrial radiation into space, indicate that for a lampblack surface the outgoing radiation may be as high as 0.1 the incoming solar radiation. The emissivity of the materials forming the earth's surface may be much lower than this value. Nevertheless, it is much greater than can be compensated for by a continuous incoming of stellar radiation. The temperature of the earth must therefore ultimately tend towards the absolute zero of temperature.

V. Some Astroradiometric Problems that Await Solution

A complete statement can not be made of the problems in stellar radiation that require investigation. They stare one in the face whichever way one turns. Realizing the inadequacy of the radiometric apparatus now available one must sit with eyes closed in order not to become impatient with existing conditions, both as regards the production of radiometric apparatus sufficiently sensitive to make the measurements and as regards financial assistance which is necessary to carry on the work. It is not a work that can be "cleaned up" in a season. It will require years of painful, nerve-racking toil in order to accomplish anything of worth.

While it is hoped that the present investigation will make available to the astronomer one more instrument for the investigation of celestial objects, it is desirable to emphasize that, from the insensitive nature of the instrument, the astronomical application can not be very wide as compared with the spectrograph. However, its physical properties are such that, in a limited field, it can be employed in attempting the solution of some of the most fundamental questions in astrophysics. Take for example the question of the emissivity of blue stars as compared with red stars. The general conclusion appears to be that blue stars are at a higher temperature than red stars, and that the emissivity of the red stars is higher than that of the blue stars. The higher emissivity of the red stars would be attributable to a marked change in the distribution of energy in the spectrum, brought about by a change in the physical condition of the stellar surface.

With the rather insensitive radiometric outfit used in the present investigation it was shown that the total radiation received from a red star is two to three times that of a blue star of the same photometric brightness. These observations should be extended. Another field of astroradiometric research is the measurement of the radiation from

variable stars, especially those which undergo a change in color. A general radiometric survey of the stars is desirable; especially of star systems which may have companions which are too dark to detect photographically. The bright components of these stars would give an excess of total radiation as compared with other stars of the same color and having the same photometric brightness. Two stars apparently giving such an excess of total radiation were found in this preliminary survey and no doubt many other examples will be found.

It is possible that measurements of the total radiation from stars may be of assistance in answering the question whether light is absorbed in traversing interstellar space. When one considers that the measurements, made last August, on the radiations from *Polaris* (the pole star) were vibrations which were emitted forty-seven years ago, and that the radiations from the *Orion* group of stars started on their journey through space 160 years ago, the distances involved are so inconceivable that one naturally wonders how it can be possible that there is not sufficient "cosmic dust" in interstellar space to scatter and thus diminish the visible radiations to a greater extent than the invisible radiations; and yet the spectrographic evidence seems to be against this sought-for absorption of light in space. Another question awaiting solution is whether there is a "dispersion" of light in space; *i. e.*, whether there is a retardation of say the violet rays as compared with the infra-red rays, so that the infra-red rays get here quicker than do the violet rays. This can be determined by measuring the radiation from an eclipsing variable star. If there is a retardation of some of the rays then the maximum and minimum of light emission should be different for different parts of the spectrum. This, however, opens up a new question of infra-red radiation from a dark comparison star, which may cause the eclipse, and it does not seem desirable to prolong this speculation.

It is an easy matter to indicate the problems demanding solution. It is quite a different matter to produce the instruments for their solution and in leaving now the discussion of the results obtained in the present investigation it is desirable to emphasize once more that the advance made thus far in developing astroradiometric instruments is very small in comparison with what will be required in order to make real progress in the work. For example, in the pioneering work of Nichols about fifteen years ago, the radiation sensitivity of his instruments was such that a deflection of 1 mm. would have been produced on his observing scale by a candle removed to a distance of five miles. The sensitivity of the radiometric apparatus used in the present work was more than 100 times as great, so that 1 millimeter deflection would have been produced by a candle removed to a distance of fifty-three miles. However, the real knowledge will not be gained by measuring the total radiation from stars, but by dispersing the starlight and meas-

uring the distribution of energy in its spectrum. This is the dream of the experimenter, and it is the goal toward which he has turned his efforts. But, in order to accomplish useful results, the present investigation shows that the radiation sensitivity must be still further increased by a hundred-fold. In other words, the radiometric outfit (including the reflecting mirror) must be sufficiently sensitive to detect the radiation from a candle at a distance of more than 500 miles. The instrument must be 10,000 times more sensitive than the one used by Nichols fifteen years ago, and perhaps from 100,000 to 500,000 times more sensitive than those used in the earliest attempts by Huggins and others, almost half a century ago. This shows how insignificant has been the gain in sensitivity in comparison with what will be required in order to accomplish much on the radiation from stars. It will be a nerve-racking investigation; but it is not so appalling as the above figures may indicate. Large reflectors are becoming more common every year. However, a very large reflecting mirror may not be desirable. The gain in light-gathering power in a very large reflecting telescope is not at all proportionate to the cost of manufacture and convenience of operation. The writer used a three-foot reflector, which, although operated by hand, could be set very quickly. If a six-foot reflector had been at his disposal the sensitivity would have been increased by only four-fold. This shows how little is contributed by the mirror, and how much of the burden as regards gain in sensitivity falls upon the radiometer.

The aforementioned extra hundred-fold gain in sensitivity required may be attained by the use of a reflecting telescope having a mirror seven feet in diameter, and by increasing the radiometer sensitivity twenty times. If the sensitivity of the thermocouples used in the present work can be increased two-fold, this will leave the galvanometer sensitivity to be increased ten-fold. By using a special pier for the galvanometer, and by using a light galvanometer suspension in a vacuum, it will not be a very difficult task to increase the galvanometer sensitivity ten- to twenty-fold. It looks, then, as though everything were in our grasp—everything except a six- to seven-foot mirror, set apart primarily for astroradiometric work. When one thinks of all the money wasted in idle pleasure, and in the wars of nations, it is pathetic to realize that but for a few hundred thousand dollars the aforementioned "layman" of this generation might live to see something "practical" forthcoming from the investigation of the radiation from stars.

THE EARTHQUAKE AREAS OF THE EARTH WITH SPECIAL REFERENCE TO THE RECENT ITALIAN EARTHQUAKE

By Professor J. SHARSHALL GRASTY
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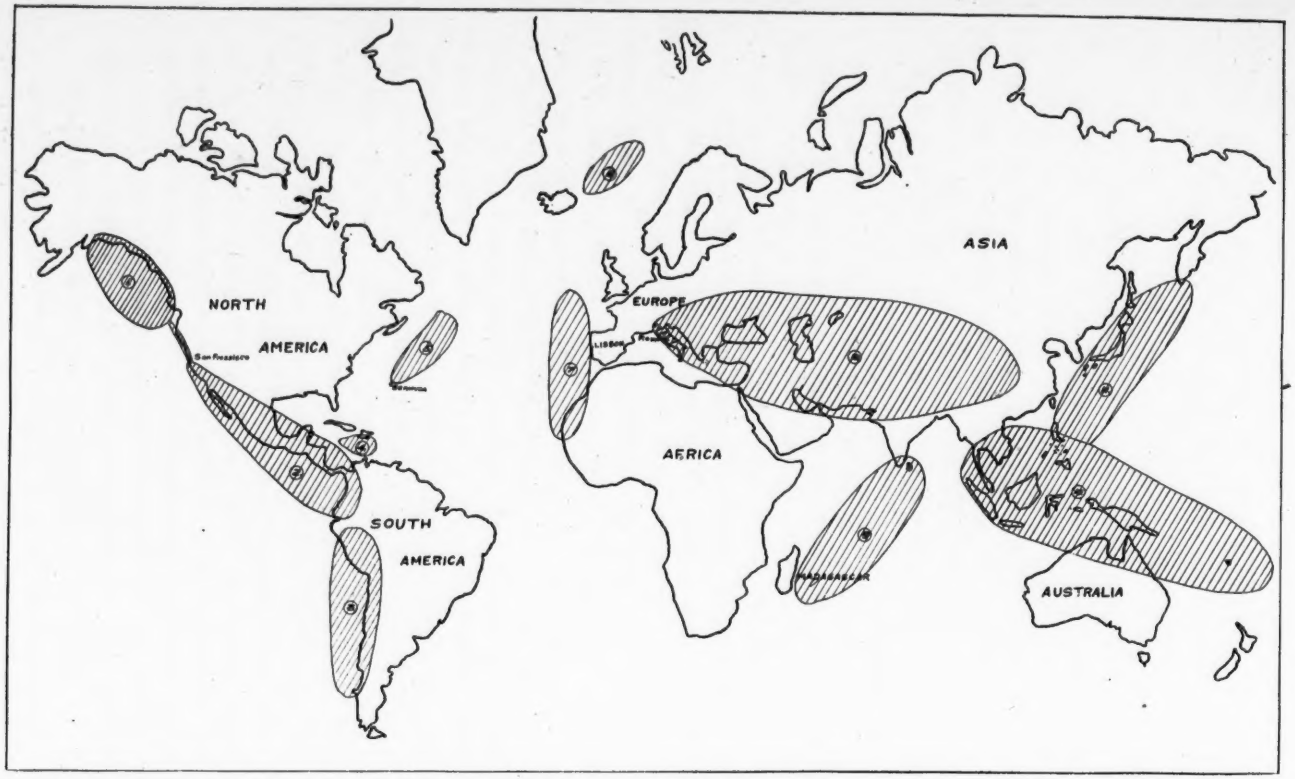
THE recent Italian earthquake, which occurred on January 13 at a cost of 30,000 lives and $60,000,000 in property, calls attention to the fact that the most disastrous shocks of this sort are, in general, not connected at all with volcanoes or volcanic areas. This is contrary, of course, to the view widely held that all earthquakes are caused by, or in some way connected with, volcanic activity. In disproof of this view may be mentioned the great Calabrian earthquake of 1783. This great earthquake occurred in southwestern Italy, but in no wise affected the volcanic areas, and this is also true of the terrible Messina earthquake of 1908, which, though it devastated various towns and cities in that part of Sicily not far distant from Mount Etna, arose from earth movements in the Strait of Messina. It was not at all connected with Etna, which at that time exhibited no unusual volcanic activity, and, too, there were no other evidences that could possibly suggest its connection with the earthquake just alluded to.

The recent earthquake which first occurred east of Rome in the Abruzzi district was followed by severe shocks in the province of Calabria. Neither Vesuvius nor Etna is reported as exhibiting any special activity. Indeed it is evident that they are in no way connected with these shocks which have been so appallingly destructive of life and property.

Broadly speaking, there are two types of earthquakes, namely, the volcanic, which is due to shocks accompanying volcanic explosions, and the more disturbing and disastrous tectonic type, caused by faulting and fissuring accompanying warping of the earth's so-called crust. In Italy, these tectonic earthquakes, such as the Calabrian earthquake of 1783, the Messina earthquake of 1908, and the recent earthquake that wrought such destruction in the Abruzzi district are all of the tectonic type, and all are the result of earth fractures brought about by mountain-making movements. In this connection it will be of interest to consider just what areas of the earth are affected in this way, and why, in certain regions, earthquakes both occur and recur, while, on the other hand, similar earth movements are not experienced nor to be anticipated in regions where mountain-making movements are no longer actively in progress.

The greatest of the Italian earthquakes have been the result of earth fracture accompanied by a succession of destructive shocks. They have been due to the fact that Italy lies within an area characterized by a state of unstable equilibrium. Its mountains and the most lofty mountains of the world, the Himalayas, were uplifted during the last great period of mountain-building—for it must be remembered that not all mountains are of the same age—and that the rocks of the earth had been folded into great arches, upon which were superinduced other folds, long before the uplift of the Himalayas. In other words, most of the highest mountains of the earth are much younger geologically than the older and less lofty ranges, just as the Rockies are vastly younger than the mountains of the Appalachian region, while they, in turn, are much younger than the Blue Ridge—itself younger than the remnants of other mountains which, however, in the attribute of elevation, are mountains no longer—since now only their upturned eroded roots remain marking sites where their masses formerly stood in the long distant past, as great, towering topographic features. Old mountains thus become bevelled off and their sediments may again, in the evolution of the continents, be uplifted elsewhere after eons of ages to form new and even much higher mountains than before.

The cause of the movements of the earth which produce mountains is a long story in itself—and so its discussion here must needs be omitted. For our present purpose it will suffice to say that such movements do occur. Furthermore, they proceed very slowly, so slowly that while such deformations are in progress they may be at such a rate as to be wholly imperceptible and yet, acting through a vast period of time, be sufficient to lift rock formations from beneath the sea to thousands of feet above sea level. In the course of the uplift, accompanied as it is by folding, obviously enormous stresses are developed and from time to time rocks give away and fissuring and faulting ensue; and when this happens the shocks that are felt are said to be the result of what is termed a tectonic earthquake. Later on other movements may occur along a line of weakness produced in this way, and at different points along this line and at different times, just as the California earthquake was the next to the last of a series of eight movements along a well-defined line of crustal fracture. The movements which culminated in the California earthquake began in the north off the coast of British Columbia. The first and third of the series occurred in this region in September, 1899, and October, 1900. They were then felt off Central America in January, 1900, and April and September, 1902. After a lapse of over three years, sufficient stresses had accumulated to inaugurate another movement, upon the southern continuation of the same line. This shock was noted off southern South America on January 31, 1906; and then several months later came the California earthquake



MAP SHOWING THE AREAS OF THE EARTH CHIEFLY AFFECTED BY SEISMIC DISTURBANCES. It will be noted that within certain of these areas are the highest mountains of the world—which were uplifted during the most recent of the world's mountain making periods. Certain other areas are also marked by crustal warpings and such lack of equilibrium as to produce more or less frequent earthquakes.

1. Alaska-British Columbia belt. 2. California-Ecuador belt. 3. Peru-Patagonia belt. 4. West Indian area. 5. Bermuda area. 6. Iceland area. 7. North African-Portugal-Ireland area. 8. Alpine-Himalayan area. 9. South Indian-Madagascar region. 10. Malaysian area. 11. Japan-Philippine area.

of April 18, of the same year (1906). The last and the southernmost of the series occurred on August 12, 1906, and devastated southern Peru and Chile. These various shocks occurred, as stated, along the same line of crustal weakness and parallel to geologically young and lofty mountains, which appear to be still in process of growth. In the same way the Messina, Calabrian, and now this, the most recent of the Italian earthquakes, have all occurred along a line of movement which, starting in southwestern Italy, has experienced movement both further to the southwest and to the north—the last developing along this line of dislocation in the extension of the uplift marked by the Appenines into the division of Abruzzi. Along the same line other shocks will probably be felt from time to time, though there is no telling even approximately as to what the length of this time interval may be. Another series of shocks may occur while this article is being printed, or months, years, or even a century or more may pass before another pronounced movement takes place along the Calabrian-Abruzzi line of fracture; but that it must occur again sooner or later is almost a certainty.

In the regions of old rocks of the earth's crust or in regions of old mountain ranges, a state of equilibrium has been so nearly approached that few earthquake shocks occur. However, in those areas of the earth where young mountain ranges rise or where earth movements are in progress, seismic disturbances are more or less frequent. With the data now available we may map with a very fair degree of accuracy eleven such earthquake areas, all of which are shown on the accompanying map. Also it is worthy of note that the areas chiefly affected by earthquakes are occupied by rocks which are post-Paleozoic in age, and hence, geologically speaking, are relatively young.

The largest earthquake region of the world, which we may term the Alpine-Himalayan area, extends from the Alps to the east of central China. As is shown on the accompanying map, Italy, the eastern Mediterranean, and the warped-down basin of the Caspian, all fall within this area, as do also the Alps, and the young and probably still growing mountain chain of the Himalayas, whose rocks were laid down in the sea at a time, in the geological past, when the Mediterranean formed a connecting link between the Atlantic and Pacific oceans. Within the limits of this region shown on our map, it is estimated that fully 20 per cent. of the more important and widely felt earthquakes occur. The Malaysian earthquake region lies further east. It extends from the Bay of Bengal, across northern Australia, to the region of the Pacific north of New Zealand, and it also embraces all of the East Indian Islands. Its axis probably follows the alignment of the various young and growing mountain regions that traverse the islands of this Archipelago. To the north of the Malaysian belt is the earthquake region which includes the Archipelago of Japan and the Philippine Islands.

As is well known, the islands of the former are almost constantly shaken by earthquakes. This region and the East Indian region, as will be observed from the map, are not sharply marked off from one another.

Along the western coast of North America, there are three earthquake regions. These are shown separately, but as a matter of fact are connected by narrow strips, marking areas of more restricted seismic disturbance. The central belt is thus to be connected, on the one hand, with the southern belt, and, on the other, with the northern belt. The most northern of these three belts lies along the coast of Alaska and British Columbia; the central or California-Ecuador belt, begins in California, includes all of Central America, and ends in Ecuador; the southern, or Peru-Patagonia belt, follows the coast of South America from Peru to Patagonia.

Both the West Indian and the South Indian-Madagascar earthquake regions extend over areas which have experienced more or less profound downward crustal warping. The West Indian region, possessing definite features of marked structural instability, suggest the Malaysian area, which latter, however, is characterized by young and growing mountains, but also exhibits in certain of its parts warping of the kind previously alluded to. The West Indian area is also a region of unusually active earthquakes which are due doubtless to a continuance of the earth's movements by which the old continent of Antilla has been broken up into the islands that go to make the present Archipelago. The South Indian-Madagascar region is supposed to mark the site of a former land mass now vanished under the Indian Ocean. This earthquake region extends from South India in a southwesterly direction to the island of Mauritius and to the east of Madagascar.

The North Atlantic may be divided into three earthquake regions—of these three, one lies northeast of Iceland and parallels the coast of Scandinavia. The second and largest of these three regions extends from North Africa in a northward direction along and past the coasts of Spain and Portugal to the west of the Bay of Biscay, and thence to the west of Ireland. It was along the line of movement here described that there developed the terrible Lisbon earthquake. The third of these areas, which is about the size of the first and the least active of the three, parallels the eastern coast of the United States and includes the islands of the Bermudas.

Some of these earthquake regions, such as the last of the eleven mentioned, are notably free from violent volcanic activity; but, as we have seen, even in a region containing an active volcano the most powerful earthquakes often affect the non-volcanic districts. Thus, to recapitulate, the appalling Calabrian earthquake of 1783, though near the volcanic areas of Sicily and not a great distance from Vesuvius, affected a part of southern Italy where there are no volcanic rocks. The dis-

astrous Lisbon earthquake was also in a non-volcanic area. Likewise, the region of occurrence of the recent Italian earthquake shows that it also is situated in a non-volcanic area. Furthermore, as a general rule —though earthquakes often happen in volcanic regions due to explosive shocks—the most disastrous and most powerful earthquakes occur in non-volcanic areas and are tectonic in their nature. They—the latter—are due to a series of rapid shocks which accompany movements along lines of weakness, such as faults or previously made fissures due to mountain-making movements. The throw of these faults need not be very great in order to produce disastrous results.

The frequent coincidence in the distribution of earthquakes and volcanoes may be said to be due to their dependence upon a common cause, in the sense that volcanoes may be regarded as incidental to and the result of great earth movements. Such movements evidence either the collapse of large areas of the earth's crust, or crustal uplift—each a warping, and both due to movements of an orogenic or mountain-making character. These crustal crinklings, moreover, which occur on a vast scale, are not confined to one period of the earth's history, but have been experienced by the earth at different times since the very beginning and are likely to continue to the end—which, considering the physics of the earth, and various well-known geological facts, appears to be fully as remote as the genesis of the earth itself.

A HISTORY OF TAHITI. III

By Dr. ALFRED GOLDSBOROUGH MAYER
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SUDDENLY, on September 3, 1803, Pomare I. died, and was succeeded by his son, the weak, savage, drunkard Pomare II.; Who even with European aid was unable to maintain his power, so detested was he even in his own ancestral district. Thus, in 1808, the new "king," together with his ministerial allies, were forced to flee to the Island of Eimeo, the Tahitians under Opuhara of Papara having utterly routed them without a convert having been gained to Christianity.

After this, in October, 1809, all but two of the missionaries set sail for Australia, leaving only Mr. Nott and Mr. Hayward, who retreated to the Island of Huahine, leaving their friend the "king" a lonely exile upon the little Island of Eimeo, his "Elba" being but ten miles long and five wide. Deserted and helpless, even his native district lost, Pomare came to realize that his sole hope lay in inducing the missionaries to return to his aid. Thus, in 1811, did Pomare II. regain his allies, exhibiting his "change of heart" by begging for baptism from their hands in July, 1812.

This case is by no means unique among the annals of missionary success in the Pacific, for Thakombau of Fiji became a convert only when missionary aid became indispensable to maintain his power, and George Tubou of Tonga gained greatly in material things through his acceptance of Christianity.

In order to appreciate the victory of the missionaries in causing Pomare to accept Christianity, we must remember that the high chiefs in Polynesia were leaders in spiritual far more than in temporal things, and conversion was tantamount upon their part to an abnegation of their godly origin. Thus it was that at first no natives would follow the example of Pomare, all believing him to be mentally deranged. His act seemed that of a Sampson who in despair had crashed the temple upon his own head.

Converts followed slowly, some from conviction, others probably perceiving, as Pomare appears to have done, the worldly advantages to be gained, and thus in 1813 the idols of Eimeo were publicly burned to the great joy of the missionaries, who thereafter gained rapidly in political power and religious authority, arming their converts with both guns and Bibles.[6] Thus in 1815 the missionary party became strong enough to invade Tahiti; and in November of that year they gained a

[6] See "The Memoirs of Arii Taimai," p. 160.

"The Diadem," Fautaua Valley, Tahiti.

decisive victory, killing Opuhara, the leader of "the Conservatives," and enabling Pomare to capture and destroy the idol of the great god Oro, the "ancestor of the chiefs," a huge, uncarved log covered with red and yellow feathers. Thus through methods savoring more of Mahomet than of Christ was Tahiti converted.

Soon all old customs were crushed out; European clothing and manners were introduced, and rigid laws were enacted obliging all to conform to the outward forms of Christian worship.

A priestly despotism similar to that which prevailed in the seventeenth century in Puritan New England was inaugurated; the Sabbath commencing on Saturday afternoon every one being obliged under penalty of a heavy fine to attend the services of the church. To-day, in the Ellice and Gilbert islands and in other remote parts of Polynesia, a similar tyranny is maintained.

Pomare was "king," but his power was broken never to be restored, and the actual government of Tahiti was in European hands.

The tabu system having been destroyed, Mr. Nott, one of the original missionaries, devised a code of laws in 1819, the "king," chiefs, and people all approving by raising their hands at a public gathering. These laws were still further elaborated in 1826 and were designed to provide a regular system of taxes (tribute), and penalties. The following table may be interesting, for it serves to give an insight into the mental character, spirit of toleration, and power to enforce their rule enjoyed by the missionaries:

Crime	*Penalty*
Working on Sunday, first offense.	To make a road 300 feet long and 6 feet wide.
Working on Sunday, second offense.	A road 660 feet long.
Stirring up rebellion.	A road 660 feet long.
Murder or infanticide.	Banishment to some lonely island for life.
Bigamy for men.	A road 240 feet long and 6 feet wide.
Bigamy for women.	To make two floor-mats.
For being tatooed.	A road 60 feet long, and the tatoo-marks to be obliterated by blacking them over.
Drunkenness in men.	A road 30 feet long.
Drunkenness in women.	Two large mats.
Stealing a pig.	A fine of 4 pigs, two for the owner and two for the king.

As Ellis says

> the law which prohibits labor on the Sabbath day is perhaps enforced by a penalty disproportionate to the offense.

In most of these penalties a part of the fine went to benefit the king or district chief, who thus profited through the dereliction of his sub-

HOUSE AND NATIVES OF BORA BORA, SOCIETY ISLANDS.

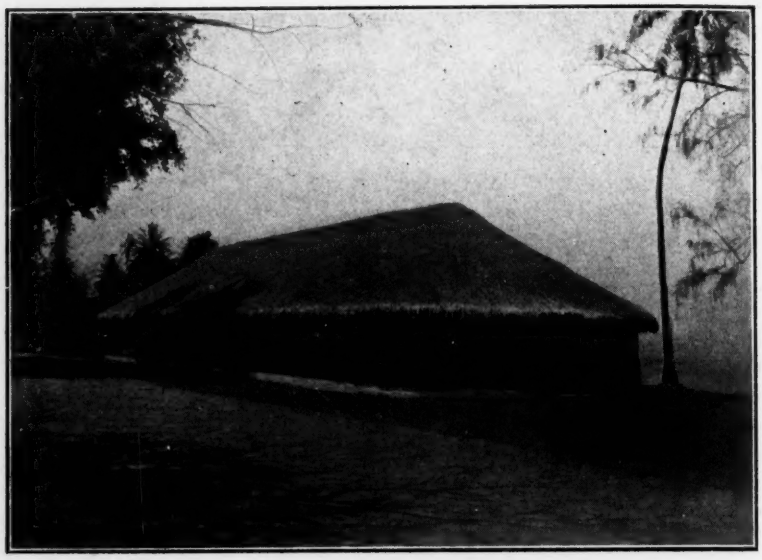
jects; and the system of espionage and development of hypocrisy and deceit resulting from such a system may well be imagined, or, if not comprehended, may be observed to-day among the natives of the Ellice and Gilbert Islands.

Having given Tahiti a code of laws, the missionaries proceeded to write out the plan of a "constitutional monarchy" and a "parliament" patterned upon that of England, but Pomare and the high chiefs would have none of it, and the scheme could not be thrust upon the natives until after the death of the king in 1821; when owing to his son Pomare III. being an infant, a "regency" was established and the power of the missionary party was much augmented, although always opposed by the conservatives under Tati, chief of Papara.

Thus in less than a decade were the Tahitians driven over the road of political and social progress that Europe had toiled a thousand years to traverse. The natives were forced to harken to the voices of men of an alien race whose traditions differed wholly from their own, and who looked with ill-concealed contempt upon the religion, folk-lore and arts of old Tahiti, forgetful of the fact that there was much in native culture that was good and should have been encouraged as a basis for future development.

Perhaps the saddest mistake that has been made in the universal attempt to introduce our civilization among the simpler races has been the destruction of almost all that once was theirs in the hope that things of our own creation might arise. Instead, the natives have lost much and gained but little. Under friendly direction, the wonderful

wood carving of the Maoris might have been preserved and modified to find a profit-producing market for the natives. The embroidered mats of the Marshall Islanders were the admiration of all who beheld them, so beautiful were their designs and soft their texture. Even so low a race as that of Australia can produce basket-work of superior quality which if honestly encouraged could provide a means of attaining affluence from the native standpoint. The salvation of their very souls lies in the maintenance of their respect as self-supporting men and women, yet even while we preach morality, we permit their only hope of maintaining it to dwindle through our own neglect to find a market for the fruits of their labor and invention. Yet, happily, a ray of hope has come, and on the island of Badu in Torres Straits a laudable attempt is being made



COUNCIL HOUSE AT PAAIA, TAHITI.

by an incorporated English company under the direction of the Reverend F. W. Walker to teach the natives money-making arts and trades and, above all, to procure and develop a market for their wares. No surer road to the attainment of civilization and Christianity could be found and there is a most significant contrast between the industrious, happy natives of Badu, whose faces are alive with intelligence, and hope, and their listless cousins of other islands in Torres Straits.

Perhaps it was but natural that these early Tahitian missionaries grew too greatly to fear mistakes upon the part of the natives, forgetting that the teacher must not do the reading for the child.

A semblance of order and rectitude fell over the stultified life of the natives, while hidden beneath the surface vile things survived concealed. Such a vision of "righteousness" one sees among that most "orderly,

HOUSE NEAR PAPARA, TAHITI.

well behaved, and moral" community; the convicts of our own state's prisons. Yet progress lives only where action is free to try the unknown, hoping that despite mistakes truth may thereby be revealed, and in proportion as men have won this right does bigotry lose its hold upon their souls.

Yet happily there are other and more important sides to this picture

NATIVE HOUSE AT PAPARA, TAHITI.

of the work the missionaries accomplished in Tahiti. Rather the truth is that, realizing the fundamental good they accomplished, we, in our regret for their partial failures, are disposed to dwell too deeply upon the darker side. Let us therefore not forget the better things they wrought for, and the difficulties which their courage surmounted. Had they not come there would be no native race living in the Tahiti of to-day, for with their success, the institutions of infant murder, human sacrifice, native warfare and the society of the Aroei disappeared forever from the land.

Nor must we overlook the bravery of this little band, every one of whom had been threatened many times with death, and at least one of whom had fallen a victim to native hatred. Friendless and far from home, alone, and unprotected, they had labored steadfastly throughout the long sad years of apparent failure, and it seems but natural that in the end they became in some measure the victims of the elation of success.

It was fortunate that from 1817 to 1824 William Ellis, a kindly, tactful and courageous man lived as a missionary upon Tahiti, for not only did he give us in his well-known "Polynesian Researches" the fullest account extant of Tahiti in old days, but his efforts were directed toward encouraging new industries to take the place of many occupations which had been lost.

Among all the missionaries, Ellis appears to be the only one who expressed regret at the abeyance of such harmless sports as archery, surf-board riding, playing with miniature canoes, flying kites, and swinging upon ropes; for the Tahitians were not gamblers as were the Hawaiians; but he says

> the adults [Tahitians] do not appear to have thought of following this [archery] or any other game since Christianity has been introduced among them.

Moreover in Tahiti, as elsewhere under the domination of European culture, the native crafts of wood-carving and tapa manufacturing were discouraged and lost, and the great double-decked canoes one hundred feet in length with their ornately carved bows curving upward, were made no longer, and even the Ariirahi's state canoe, called the Anuanua (the rainbow), was doomed to disappear.

In speaking of Tahiti as it was in 1839, Admiral Charles Wilkes, who always champions the introduction of European culture, says:

> The change of dress which has been introduced by the missionaries, and other foreigners, has had an injurious effect on the industry of this people. While they wore the native tapa the fabric, though of little value, gave employment to numbers of women; and this change of dress intended as an advance in civilization, has had the effect of superseding employments which formerly engaged their attention and occupied their time. The idleness hence arising, and the artificial wants thus created, have no little influence in perpetuating licentiousness among the females, to whom foreign finery is a great temptation.

In old days beautiful bowls, pillows and seats were carved by the natives out of single pieces of wood, but these also were doomed when brought into competition with even the crudest articles of European manufacture, and moreover their symbolism was repugnant to the new regime, for it maintained the memories of old traditions.

EASTER ISLAND STONE IMAGE IN THE GARDEN OF THE ESTATE OF JOHN BRANDER, ESQ., AT PAPEETE, TAHITI.

It should be said that in 1818 the missionaries sought to introduce such civilized employments as the manufacture of cotton cloth, and the cultivation of sugar, coffee and tobacco, and the making of lime for the concrete required in the construction of the ugly, stuffy, little stone houses which were intended to supplant the well-ventilated native thatch. They even went so far as to import a Mr. Gyles from Jamaica to introduce the manufacture of sugar from the cane. He succeeded, but Pomare and the chiefs became fearful that should the industry prove commercially profitable foreign men-of-war would descend upon

Tahiti and the natives would be deprived of their lands and reduced to slavery as were the Indians of the West Indies. The opposition of the chiefs was of so determined a nature that the missionaries deemed it advisable to desist from their attempt, and their effort to introduce a cotton-cloth mill met with similar discouragement.

Indeed, it is doubtful whether the child-like natives would have been either happier or better as mill hands laboring eight or ten hours a day in distilleries or factories than they were each in his own house beneath the palm groves and depending upon the rich bounty of the land and sea for food and clothing. These European autocrats sought in all reforms to begin at the top, and had they displayed the good judgment to teach merely the rudiments of religion, government and agriculture, and to encourage and develop a market for the crafts the natives already practised, they would probably not have felt obliged to complain to Admiral Wilkes that "sincere piety was rarely to be found among the natives."

In 1821 a rebellious return to idolatry broke out among the young and aristocratic element, and after this was sternly suppressed a fanatical sect, the Mamaia, arose in 1828, their leader claiming to be Christ and promising a sensual paradise to his followers. The natives who at first had expected miracles from the white man's god, were now beginning to lose faith and interest and to loathe the dull life their masters forced upon them, and in 1839, when Admiral Wilkes visited Tahiti he was surprised to find the attendance upon worship on Sunday to be small, less than 200 being present in the church, and most of these being women who "did not appear to be as attentive as they had been represented." These women, he says,

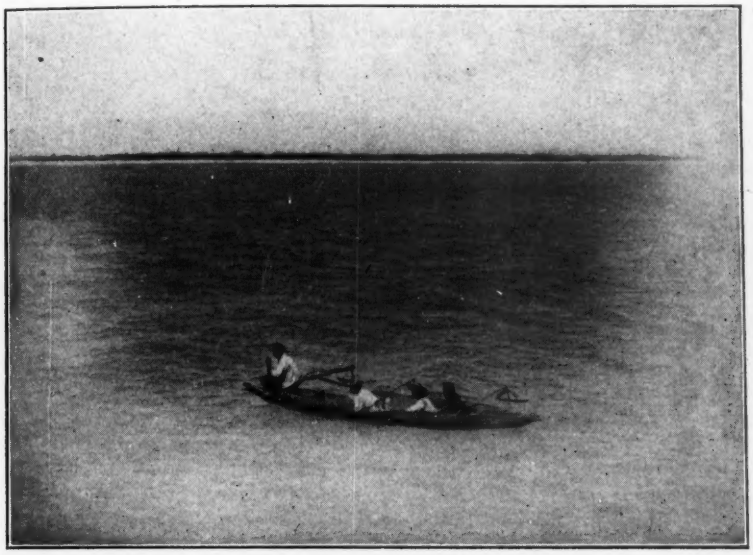
> were dressed in a most unbecoming manner in high flaring chip bonnets of their own manufacture, loose gray flowing silk frocks, with showy kerchiefs tied around their necks.

The time has come when the natives of Polynesia are beginning to appeal for freedom to govern and maintain their own churches and under ministers of their own race; to suffer from their own mistakes and win their own achievements.

Yet a great task still remains to the European co-worker for their enlightenment, for everywhere there is a crying need for manual training and technical schools patterned upon the general plan of Booker Washington's Tuskegee Institute. Above all, markets must be sought and developed for the wares and produce of the natives, for most of their present apathy is due to the fact that they can obtain no adequate remuneration of the products of their labor, but are, in effect, penalized for their very industry through the rapacious acts of traders.

Moreover, the present rule of the religious autocrat, essentially altruistic and high minded as it is, has produced only obedient or servile

children. Justice demands freedom for the Polynesian—room in which to struggle and to rise. It is an inadequate defense of the present system to say that it is immeasurably more humane than the savage rule of the old chiefs, for it has proven itself incompetent to raise a single native race into a position of self-supporting independence. We have given them the Bible, but we still withhold from them the means to win their moral self-respect. In other words, the task of the European is



CANOE AT NUKUTAVAKE ATOLL, PAUMOTUS.

but half completed, and the effect of leaving it at this stage is all too apparent in long settled regions such as the Hawaiian Islands, where, after the most easily attained conversion in the history of the Pacific, the natives have steadily sunken, and are to-day a degraded, downcast remnant—mere peons of commercialism, their past forgotten and their future hopeless.

How different this history might have been if along with instruction respecting the lives of Adam and Eve, Abraham, and Sampson, the missionaries had maintained the native arts, modifying them to meet the demands of markets which might have provided the native race with a means of livelihood and replaced the lost ambition due to the abolition of war. Beautiful wall papers and screens might have been made from the delicate tapas of old Hawaii, and their women were once skilled to an unusual degree in feather work and weaving.

We speak of the island races as being "lazy," forgetting that there is as yet no adequate reward for their labor. When opportunity offers, they strive well, as in the crude process of the copra industry, which, after

having been introduced by the great German merchant, Godeffroy, in the middle of the nineteenth century, has proved to be the commercial salvation of Polynesia.

But to return to the political history of Tahiti. On December 7, 1821, Pomare II. died as a result of long-continued drunkenness, and on April 21, 1824, his son, a boy of four years, was crowned by Mr. Nott, one of the original missionaries as "Pomare III., constitutional king of Tahiti." The education of the young "king" was at once undertaken by the missionaries, but on January 11, 1827, he died of an epidemic which was then ravaging the island; and Aimata, his half sister, was proclaimed queen, taking the name of Pomare-Vahine (The Lady Pomare), although more commonly known as "Queen Pomare IV."

At the time of her accession she was only about thirteen years of age, and thus dependent upon the missionaries for advice, and, as the sequel proved, rarely was queen more in need of broad-minded and tactful advisers, for the end of Tahitian independence was at hand, and the fateful question was—should England or should France assume the government of the island?

Several elements in the foreign population were causing trouble to the natives, these being the traders who sought to bleed the Tahitians of all the little wealth they possessed, the degenerate deserters from ships and other parasitic whites who were a constant source of demoralization, and the sons of the missionaries, who, in general, lacked the altruism of their parents and sought to acquire land and to exploit the Island at the expense of the natives. Conditions such as these have worked themselves out in the Hawaiian Islands, ending by the descendants of the missionaries acquiring nearly all the lands the natives once possessed.

In Tahiti the native chiefs, following the policy they adopted in respect to the cultivation of sugar cane, had determined to discourage the permanent residence of white men among them, and had steadfastly refused to sell or even to grant long leases to their land, and thus the natives as a race were still independent home-owners, and happy in the enjoyment of their accustomed means of obtaining sustenance.

The salient fact is that the white settler in the tropics is concerned chiefly with his own profit, and but little with the elevation of the native race. Through artificial devices designed to restrict the liberty of the natives, or through the imposition of high taxes, the white man virtually peonizes the native race and forces the brown man to labor far beyond the little effort required to provide all his natural needs, and in the end the profit accruing from such toil is found in the pockets of the white man. To-day over those parts of the tropics wherein the white man gains a profit from the land, as in the Dutch East Indies or in parts of Africa, this modern ingenious form of slavery pertains. In other

PEARL DIVERS MOVING THEIR HOUSE, HIKUOM ISLAND, PAUMOTUS.

words, a form of commercial peonage has replaced the old possession of the body of the slave, and only in proportion as the land is poor, or markets far away, is the native rich in communal liberty.

These facts, well appreciated as they are by the natives are the chief causes of racial distrust, for the native realizes that the European is his exploiter, not his friend. Unable to maintain his ground in open contest, he has recourse to all manner of subterfuge. Much of his so-called "laziness" and "lack of ambition" results from these conditions, for while he is sufficiently industrious and often hard working in so far as his own personal needs and profits are concerned; if he can by any means avoid working for the white man's benefit he will do so, even though he must himself endure privation to accomplish this end.[7]

Events in Tahiti moved slowly, for the age of the steamship had not yet come, and the South Sea Islands were still remote from the world's activity.

In 1835 the Catholics began to establish missions among the Pacific Islands, and thus the French government acquired a plausible reason for sending men-of-war into the Pacific, avowedly to afford protection to these missions, but in reality to expand the realms of France.

In Tahiti the drama opened when two French priests, Fathers Laval and Caret, embarked upon a small schooner from Mangareva and landed on Tahiti on November 21, 1836.

The antagonism between the protestant missionaries and their catholic co-workers was well known to these French priests, and thus they avoided Papeete, the only port of entry, and sought a landing upon the remote coast of Tautira on the eastern side of the Island. They then walked slowly along the shore toward Papeete preaching at frequent intervals, and gaining the ears of Tati and other leaders of the old conservative party whose aspirations had been crushed by the missionary element in 1815.

Henceforth the struggle lay between the protestants and the French, the Queen being but a puppet in the hands of Mr. Pritchard, a missionary who was then serving as British Consul; and the upshot of the affair was that on December 13, 1836, the priests were expelled from Tahiti for having failed to respect the port regulations in landing surreptitiously at Tautira; their offer to pay the statutory fine being refused by the Queen.

But the martyr spirit was as strong in these French priests as in their protestant adversaries, and with unexpected suddenness they reappeared, this time as passengers on the American brig *Colombo* which anchored in Papeete Harbor on January 27, 1837. Their application for per-

[7] A most interesting and thoughtful analysis of such conditions has been given by Sir Sydney Oliver, former Governor of Jamaica, in his book upon "White Capital and Colored Labor."

mission to land met with a prompt refusal, and with their disappearance the curtain falls upon the first scene of the drama.

The second opens when on August 29, 1838, the French frigate *Venus,* under Commodore DuPetit-Thouars, bore down upon Papeete, and, training her guns upon the town, demanded first an apology, second 2,000 Spanish dollars, and third a salute of twenty-one guns for the French flag.

The native sources of money-revenue were derived largely from washing done for ships, of which employment Her Majesty and the high chiefs enjoyed a monopoly, and the hopelessness of attempting to pay this enormous indemnity was so overpowering that in her despair the Queen is said to have advised the ceding of the entire Island to the French.

Even had the town been shelled, retreat to the hillsides would have given the natives hardly more concern than in the days of Wallis, but it was far otherwise with the English residents, who, moreover, were already scheming for a British protectorate. Thus the foreign residents came to the aid of the Queen and the indemnity was promptly paid, the French, however, being obliged to provide the powder used to salute their own flag, for, as Mr. Pritchard states in his "Polynesian Reminiscences," upon the entire Island there was not sufficient powder for more than five of the twenty-one shots required.[8]

The French Commodore then demanded a treaty by virtue of which Frenchmen of all professions were to be permitted to establish themselves upon Tahiti; and after obliging the Queen to accept a French Consul of his own choosing, the *Venus* sailed away.

Most unwisely, immediately after the departure of the *Venus,* the Queen, instigated by Pritchard and the missionaries, issued a law forbidding the teaching of Roman Catholic doctrines in Tahiti; when, like a bird of ill omen, another frigate *L'Artemise* rose above the horizon, but in approaching the island she struck so heavily upon the coral reef that had it not been for native aid in towing her into Papeete Harbor she would have sunk. No sooner were her injuries repaired, however, than her captain, running out his guns, demanded equal rights for both Catholics and Protestants, and the cession of a site for a Roman Catholic church. Soon after this in 1841 the chiefs of the old conservative party applied to France for protection; the Queen, instigated by Pritchard, having already addressed a similar appeal to England.[9]

A semblance of peace then fell upon the scene and for several years

[8] This event is depicted in Plate No. 53 accompanying the "Voyage autour du monde" by A. DuPetit-Thouars, Paris, 1841.

[9] Great Britain responded by a pleasing but non-commital letter, and a gift to the queen of some household furniture, which through an irony of fate arrived just in time to be of service to Bruat, the first French Governor.

the wide waste of the Pacific seemed to afford the protection of isolation to the little island. But the government of Louis Philippe was casting covetous eyes upon the Pacific, usurpation at home having bred aggression abroad; and in September, 1842, the sails of another frigate, *La Reine Blanche,* rose and shaped themselves upon that eastern horizon whence in other days Wallis, and Cook, and Bougainville had come, and the evil genius of Tahiti, DuPetit-Thouars, once more frowned down upon the affrighted land.

MORAL PROGRESS

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MORAL progress has two aspects: one, social and psychological; the other, individual and biological. The former appears to have a superficial, temporary and changeable basis, with an element of compulsion; the latter appears to be fundamental, permanent and spontaneous.

Moral conduct may be secured by the compulsion of tradition. Usages and customs exert a "steam-roller" effect in crushing out anti-social conduct. The preparation and selection of foods is almost entirely a matter of custom. Custom and style set the standards of what sort of attire is proper under given conditions. We have police ordinances which specifically prohibit indecent exposure in public places. In business relations, certain standards are recognized and some usages have received quite general acceptance. We have laws which punish felony and misdemeanor. To ignore this body of tradition is to invite social ostracism or even more summary punishment.

But most of us are subject to strange and inconsistent moral lapses. The loving father and generous husband is too often brutally unscrupulous and cruel in his business dealings. Unexpected disclosures frequently show how many of our "respected citizens" are patrons of houses of ill repute. Thus there is one code of morals in the family and another in business and outside life. Corrupt politicians are often model husbands and staunch friends, yet they feel no scruples at taking the public's money. They regard "graft" as legitimate gain. In a lesser degree, church members and moral leaders will not hesitate to cheat the transit corporation of a rightful carfare. Wealthy men will give large sums of money to charity with one hand, and with the other ruin a competitor by cut-throat methods, or solemnly dispose of worthless watered stock in a market of credulous buyers. "Gentlemen farmers" who want to liquidate a bad real estate investment will dump garbage and turn hogs into a stream which supplies a neighboring town with drinking water, in order to force the purchase of their land by the fever-threatened community. A flimsy pretext precipitates the holocaust of Europe. Thus moral conduct is often but a thin veneer which covers up unsuspected depths of primitive brutishness and crude impulse.

On the other hand, we all know certain men and women of our acquaintance who in nearly every situation seem to do the wise thing,

while others can invariably be counted upon to do the wrong thing. Halfway between, most of us stand by in hesitation. These naturally moral individuals who seem to have an innate sense of honor and proportion are found in all walks of life. They appear to be types whose general attractiveness and good sense are recognized by all classes with whom they come in contact.

Thus moral conduct which is the result of repression of anti-social impulse is but a negative social virtue. Moral conduct which is the result of spontaneous action is a positive social virtue. The former is analogous to the veneer which covers up the basic crudeness; the latter is analogous to the solid rare wood.

Historically considered, moral conduct seems to have been most frequently of the psychological sort—very rarely of the biological sort. Rigid customs and established usages have from time immemorial sought to reduce variable human units in China and India, to spiritless followers of prescribed conduct. Each new generation is remorselessly trained to mechanical practises, the following of which is thought to signify moral conduct. Oriental peoples have proceeded farther than Occidental peoples in the direction of rigidly standardizing conduct. May not the adoption in recent times of some of the freer western standards by the supposedly tradition-bound east, be taken to signify the superior practicability and greater value of plastic standards over rigid ones?

But moral conduct by compulsion is a social policy not exclusively confined to Oriental peoples. We of the western world have had our experience with political and religious intolerance. Often the compulsory production of moral conduct has been carried to such extremes that it has become more than a repressive force, it has become a selective agency. Witness the case of the Roman Catholic inquisition. By the exaction of celibacy and by the torture and death of unorthodox and original persons, the perpetuation of the most intelligent stock was hindered. The enforcement of compulsory standards of moral conduct and the extermination of the intellectual, effectively rooted out of society many of those people who had within them the possibilities of *genuine* social conduct. In this way customs have been so rigidly preserved that it seems as if their chief object has been to crush without discrimination all variation from the prescribed conduct. The ultra-conservative elements of society seem to consider that the extension of the sphere within which custom works to the line in ironing out all innovation and in rigidly standardizing conduct, is the best possible evidence of moral progress.

In recent times we have begun to think that genuine moral progress consists in the loosening up and in the simplification of binding customs. That flexible state of tradition which is consistent with the

closest adaptation of conduct as a means to the end of securing the greatest amount of enduring human happiness, is the goal. To this end we must steer between lax standards which allow license, and rigid standards which produce hypocrisy. We must avoid, on the one hand, that extreme of rigid regulation which unintelligently crushes out all variation and preserves only the spiritless, and, on the other hand, avoid that total absence of social conduct which is anarchy. Now this middle course is possible only when a majority of the people are moral by nature. The reason for this is the fact that most people need the constant pressure of custom to force them to lead thoroughly moral lives, hence only the naturally moral person will lead the moral life in a society of plastic standards. The problem of moral progress is therefore twofold: first, of creating flexible standards which will allow variation and adaptation to changing needs; second, of securing the preservation and perpetuation of a human stock that may be depended upon to lead moral lives without the necessity of much social compulsion.

In considering these problems, it should be noted that during the historical period there appears to have been little, if any, improvement in the innate mental constitution of man. While other animal species have advanced because of improvement in the stock, man's progress has been chiefly due to improvement in the *content of his tradition,* which, as generations have come and gone, has been worked over, until, by the gradual elimination of the superstitious, superfluous, irrational and inconsistent elements, it has become more elastic and better adapted to changing needs and interests. This progress can be well illustrated by a comparison of the content of the mind of primitive man with that of modern man. The tradition of many primitive groups is that disease is an *object* which can be driven or frightened away from the body of the sick person by proper charms, dances and alarming noises. After one of these grotesque ceremonies, the medicine man exhibits a quartz crystal which is supposed to represent the disease that he has taken from the person in the course of making him well. Compare this with the modern notion that disease is a disordered condition of the mind or body, and that by rest, proper food, care, drugs, and exercise, the body can be restored to a normal healthy condition. As a means to the end of curing the sick, the primitive method is quite wide of the mark, ridiculously crude as compared with the efficient methods of scientific medicine—vaccination, anti-toxin, antisepsis and aseptic methods. The difference between the two systems is simply that our modern methods are the result of a longer experience, during which, in the course of experiment, trial and failure, we have learned to eliminate many superfluous efforts and inconsistent practises. Thus the usages of civilized man are more efficient instruments to certain ends than are the customs of primitive men.

In recent times the improvement of the great body of human tradition has been greatly accelerated by remarkable advances in the means of communication. Under the incidence of those broadening influences represented by the press, the railroad, the steamship, the telegraph and the telephone, local prejudices and customs are gradually breaking down. The enormous expansion of commercial enterprises and the ease of travel have developed a tolerance of thought undreamed of a few generations ago. We do not hear so much in these days of the "Heathen Chinee," and much of the virulence of other national and racial prejudices has been softened. Communities which have developed picturesque usages on account of their isolation from the great current of human thought and ideas at the swarming centers of civilization, are gradually losing their old-time seclusion with the introduction of the railroad, the telegraph, the telephone and the camera. By overcoming the restraining conditions of time and space, the great modern inventions have combined to loosen up the former rigidity of tradition, thus making for more flexible standards.

But as we have stated above, the enduring character of a civilization whose standards are fluid and plastic, depends upon the quality of the people. There appears to be no scientific reason for believing that the mind of modern man is in any marked way superior to the mind of primitive man. The reason for this is found in the fact that improvement in the innate mental constitution of a species comes only through the agency of selection, the extermination of the dull and unadaptable, the preservation of the alert and adaptable to be the progenitors of future generations. Now natural selection is not as great a factor in the lives of human beings as in the lives of other animals. Because of his greater cleverness, memory and foresight, man has been able to protect himself from many hostile forces and has materially modified the ruthless struggle for existence. Thus it has been that many individuals unfitted for a more rigorous existence have had their lives prolonged to leave more than their natural quota of sickly offspring. For this reason, leading authorities agree that there has been little improvement in the innate mental constitution of man during the historical period. In proportion as he has simplified his tradition and made of his customs more efficient instruments, man has learned to control the forces of nature which worked him harm and has been able gradually to limit the sphere within which pitiless natural selection operates.

At the present time our traditions are openly or indirectly, as the case may be, hostile to natural selection as a means of human improvement. Humanitarian ideals, democratic principles, Christian beliefs and medical practises, are unalterably opposed to the ruthless extinction of the unfit. Yet our *mores* need to have injected into them the idea that abiding human progress can come only through the improvement

of the stock of the people. Under modern social conditions improvement in the human stock can come only through securing an approximation to the selective birth-rate, since our traditions are uncompromisingly opposed to the cruelty of the selective death-rate. Therefore we ought to get into our *mores* the idea that the children of the present generation must be born of physically healthy and mentally capable parents, the idea that the propagation of the weak and defective human stocks must be stopped by humane but firm methods. If this can be done, then we shall have overcome most of the bad consequences which have resulted from our interference with the extinction of unfit members of the human race on the grounds of sympathy, mercy and pity. An approximation to the selective birth-rate is all that is practicable under the present democratic constitution of society. But since natural selection still exterminates the grossest cases of unfitness (imbeciles die before thirty years of age, consumptives die early, children of mothers and fathers who die young generally die before leaving the normal quota of offspring), the establishment of an approximately selective birth-rate will effectively limit the procreation of the other undesirable classes. In this way the cruelty of ruthless natural selection will be avoided and yet the perpetuation of the better stock secured.

Modern states have already embarked on programs of social legislation which aim at checking the multiplication of the unfit. In some states, health certificates must precede the granting of marriage licenses. In other states there are laws which require the sterilization of congenital criminals. Massachusetts is at present endeavoring to secure the segregation of feeble-minded persons during the reproductive period. In all of these ways we are endeavoring to secure an approximately selective birth-rate. What is required if this notion of the selective birth-rate is to become a widely recognized standard, is to get the idea of *better parentage* into the *mores* of the masses as the necessary complement of humanitarian, democratic, Christian and medical ideas already traditionalized. When this has been done we shall have secured a guaranty of continuous and abiding *moral progress*. Already the word "eugenics" has been taken up by popular periodicals and newspapers. *Life* pokes fun at the idea and the press has learned to use the word. Realizing that the concept of better parentage may be gotten into the popular mind by extensive educational propaganda, the Galton Laboratory for National Eugenics of the University of London, and the Eugenics Record Office of the Carnegie Station for Experimental Evolution at Cold Spring Harbor, Long Island, have embarked on programs of popular as well as scientific education in this matter.

THE PLAY ATTITUDE AND THE SCHOOL FRATERNITY

By Dr. E. L. TALBERT
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IN primitive society men hunted and fought in bands; they planned their expeditions in councils; they celebrated their victories and lamented their defeats in dance, chant and ritual. Boys early left the tutelage of their mothers, and the males—old and young—betook themselves to their "men's houses," lodges or secret societies, from which the women of the tribe were excluded. In some instances women formed like associations, expressing in this way the difference between feminine interests and the more active, predatory tendencies of men.[1]

Whatever the racial origins, the fact is plain that in children to-day there crop out instinctive proclivities to fight, to hunt, to court danger: they form gangs and secret societies in which they play the rôles of primitive man and imitate the occupations of their elders. After the earlier period of romping and playing individualistic games, they find greater delight in group games. At a certain age boys refuse to play girls' games, and separately engage in more violent, complex activities demanding general rules for their successful pursuit. Later, as the characteristics due to sexual ripening grow pronounced, the desire to please the opposite sex enters as a motive. Intricate sports are played with greater efficiency, facility in subordinating individual glory for the sake of the prestige of the team increases. When the physical and mental unrest attending dawning manhood and womanhood arises, vague, deep emotions and ideals are felt, and the occupations which in childhood were "played at" are now considered in the light of possible careers. Gradually the sense of having a mission in the world unfolds, forming one of the bases of religious awakening and interest in history and politics.

A satisfactory account of the phenomena pertaining to the social grouping of childhood and youth should include the following items. (1) It should stress the place of impulses and feelings which are ancestral, conflicting and urgent; recognizing that these impulses ripen at different periods, are roughly uniform, in spite of varying strengths in particular individuals, and that they embody combative and cooperative dispositions, both of which are essential to effective grappling with practical problems. (2) The fundamental requirement of growing organisms is overt activity and experimentation arising from imma-

[1] Webster, "Primitive Secret Societies," Ch. II.

turity and plasticity in the young of the higher animals. To master the details of a changing environment in the more serious after-life, a vast number of physical and mental coordinations must be learned. This experimental balancing of impulses is play. (3) In following out the special motives which may be found to underly play—to be a cause, the desire to create, to dramatize, to "show off"—nature urges the youth into groups, and by means of the give and take of association stimulates sentiment, imagination, leadership and that expansion of self which comes from the consciousness of participating in a group of which each member is a contributing factor and the rules of which the member obeys because he has helped to make them.

It is needless to contend that the puritanical aversion to play, remnants of which are still extant, is evidence of an antiquated psychology and a partial interpretation of morality and education. One of the encouraging indications of recent years is the general willingness to examine the phenomena of childhood and adolescence in a scientific manner without the bias of a total-depravity doctrine or the opposite dogma of the unconditional goodness of natural impulses. The real problem is now seen to be that of knowing the facts and of directing the raw material of youthful activities in a wholesome way. A resultant of the changed attitude is a keener perception of the claims of childhood outside the conventional fields of kindergarten and school—in the street, in the department store, in the factory, and in the scores of juvenile employments which are annually entered by children leaving the elementary schools. By following the lead of Groos and other writers we can appreciate the implications of the forces which urge boys and girls to play house, soldier and conductor, to build "shacks," or to guard the grocery-corner for the exclusive nightly meetings of "the bunch." If the suggestion of the evolutionists is valid, that the baseball is a rounded missile whose progenitor was the more deadly arrow or spear, we can understand the popularity of the national sport. We can realize the possibilities which are implicit in the rivalries and emulations between gangs from different neighborhoods; and why, if there are no provisions for the safe overflow of the play impulses in a city made for adults and manufacture, trade, and other solemn "business," the legitimate desires of youth will turn to the harmful practises of outwitting the policeman, collecting stolen goods, or imitating the exciting career of the outlaw.

A second consequence of the investigation of play from the genetic standpoint is a keen awakening to the necessity of channeling the imaginative, enthusiastic energies of youth by organizing clubs, scouts and playgrounds under municipal supervision. The capital invested in social centers and playgrounds is the objective testimony to a new direction of public conscience and will. An expression of the public judg-

ment in regard to the offices of the play attitude is conveniently given in the Proceedings of the Third Annual Congress of the Playground Association of America:

1. Playgrounds to be effective must have supervisors, directors and teachers who have had such training that they understand the child and can direct his activities so as to bring about the best results mentally, morally, physically and socially.

2. Play, being the chief activity of children during infancy, contains the beginnings of all subsequent development and culture. Its function is educative, and its forms are derived from hereditary adaptations and coordinations pleasurable to us from their usefulness in the distant past of the race. We consider the chief purposes of the playground to be: (*a*) the promotion of robust health through the encouragement of a free and enjoyable life in the open air; (*b*) the development of nervous coordinations and the normal functions, especially of the vital organs, through the vigorous activity of play; (*c*) the arousing of deeper interests, emotions and enthusiasms through those activities by which the central nervous system was developed in the past of the race and to which alone it responds with full effectiveness; thus determining the energy of nervous discharge and consequent vigor of all after life; (*d*) the training in courtesy and good fellowship through those social relations of play in which friendships are chiefly formed; (*e*) the establishment of a moral trend to life through the cultivation of right habits and those loyalties on which social morality and good citizenship chiefly depend; (*f*) the cultivation of a sense of the joy of life, by which the soul is harmonized and unified and a play spirit for life's work is acquired.[2]

As to the specific qualities generated in the play group, we may repeat the conclusions of all who have looked into the matter—that the playground is a field of discipline in the elementary virtues of a democracy: loyalty, sensitivity to fair dealing, and the capacity to lead and to follow under the control of standards applicable to every one in the group. How the boy, in playing a game, puts himself in the other's place and enlarges his range of sympathy and imagery is acutely described by Joseph Lee:

The team and the plays that it executes are present in a very vivid form to his consciousness. His conscious individuality is more thoroughly lost in the sense of membership than perhaps it ever becomes in any other way. So that the sheer experience of citizenship in the simplest and essential form—of a sharing in a public consciousness, of having the social organization present as a controlling ideal in your heart—is very intense. . . .

Along with the sense of the team as a mechanical instrument, and unseparated from it in the boy's mind, is the consciousness of it as the embodiment of a common purpose. There is in team play a very intimate experience of the ways in which such a purpose is built up and made effective. You feel, though without analysis, the subtle ways in which a single strong character breaks out the road ahead and gives confidence to the rest to follow; how the creative power of one ardent imagination, bravely sustained, makes possible the putting through of the play as he conceives it. You feel to the marrow of your bones how each loyal member contributes to the salvation of all the others by holding the conception

[2] Proceedings of the Third Annual Congress of the Playground Association of America, pp. 92–93.

of the whole play so firmly in his mind as to enable them to hold it, and to participate in his single-minded determination to see it carried out. You have intimate experience of the ways in which individual members contribute to the team and of how the team, in turn, builds up their spiritual nature. . . .

It is one thing to be able to feel the swing and unity of a company marching or wheeling on a level floor; it is a very different thing to retain your sense of organization when there is a tangle of bushes or a stone wall between you and the next man on your right. . . . The triumph of the trained imagination in still holding its sense of organization under such circumstances is a notable one; especially when, as in the most successful teams, the player's grasp of the whole movement is of so masterly and flexible a nature as to be adequate not merely to carrying out a prearranged manœuvre in a rigid and unadaptable form, but to sharing with the other members of the team in the intuitive perception of such modifications as may be required by instant and unforeseen emergency.

And the team is not only an extension of the player's consciousness; it is a part of his personality. His participation has deepened from cooperation to membership. Not only is he now a part of the team, but the team is a part of him.[3]

But the social consciousness of the gang and the team has the defects of its virtues. Intelligence and adaptability may be stimulated when boys of widely differing social strata and races meet on a common footing and learn a meaning of equality which is not incompatible with assertion of individual abilities. Nevertheless, the closeness of contact and the powerful emotional appeal may induce a narrow corporate egotism sustained by uncritical custom and the hardening process which attends all institutions. Neighborhood and school may become demoralized by in-grown associations which resist all attempts to harmonize the ends of the small groups with the rights of the community. To preserve the legitimate function of primary groups and at the same time to connect them with the legitimate activities of institutions possessing wider outlooks is a problem confronting secondary schools and colleges. If the process of carrying over the attitudes built up in family and playground, of modifying and redirecting spontaneous impulses, is not done in the school, there is little guarantee that corporate loyalty, so valuable in itself, shall enter into the larger loyalties to the city and the nation.

The general difficulty, therefore, which the school has to meet is to utilize the socializing forces which seek expression in gangs, clubs and fraternities, and to eliminate harmful secrecy and clannishness. The question of fraternities in secondary schools (to which the present discussion is confined) is important because the fraternity is a type of relatively advanced associations arising when a degree of intelligence and ability to discriminate has appeared, when groups are not merely taken for granted, as they were in the period of childhood. Play in

[3] Joseph Lee, "Play as a School of the Citizen, Charities and the Commons," August 3, 1907, pp. 489–490.

early years has reference to immediate ends: as appreciation of the claims of other persons intensifies in adolescence, all pursuits can be interrogated from the standpoint of their consequences. The individual and his group can be recognized to be players in a complicated drama.

Without venturing dogmatic judgments, a few considerations to be taken into account may be outlined. If we adhere to the principles underlying American democracy, it may be asserted that in a progressive society every institution must demonstrate its right to continue by its fruits; that, on the whole, the claims of the community within which a group exists is superior to the corporate demands of the smaller group. The fraternity is one outlet of natural desires for companionship; it expresses the tendency of the like-minded to unite for forwarding their purposes: but whether the fraternity is a help or a drag is to be determined according to the same standards which decide the right to persist of any other group—family, school or political party. The queries to put to it are: Is the group open to others who are fit? Is the basis for selecting members a worthy one? Does this purpose conduce to petty rivalry or to catholicity? Is there a rule of custom which can not be reconciled with the function and public opinion of the whole school? After long experience with the workings of fraternities and sororities in secondary schools, Dr. Owen writes:

> It is idle to object to them that they are selfish and inadequate, when we remember that they are creations of young and inexperienced children. It is equally idle to declaim against them unless we can provide some other system that will do for all what they do for some. I am strongly opposed to the fraternity system in our schools, but I hope I am not bigoted on the question. My fundamental and single objection to them is the fact that they organize the school on a social basis that is narrow and selfish. I can conceive, however, of a social organization of the school in which they might possibly be of but little significance. But as long as the life of the school is what it now is, they serve but to emphasize our neglect. I can appreciate the theoretical defense made in their behalf by a culture-epoch theory of history. The simple fact is that they stand in the way of a social organization of the school that shall provide for all free expressions to social instinct, controlled development of social power, and a happy enjoyment of the society of one's fellows. The best way to deal with the school fraternity is to beat it at its own game.[4]

The specific means of attaining the "controlled development of social power" comprise all those reorganizations of outlook, method, curriculum and "uses of the school plant" which have engaged the attention of educators in recent years. In spite of considerable consensus of judgment regarding the relation of school to society, much remains to be accomplished. After years of discussion it is still pertinent to state that the work of making the secondary school a genuine

[4] W. B. Owen, "Social Education through the School," *The School Review*, Vol. 15, pp. 23–24.

community is not that of creation out of nothing, but of extending and correlating social tendencies already operating; that the problem of assimilating the non-social factions in the school is not one of mechanical adjustment and stricter discipline. If the school as a group is to compete with the narrower loyalties aroused by clique and fraternity it must stand in the minds of teachers, parents and students, for intense, live and big purposes—racial, occupational and civic. It must supply on a large scale the values which exist in small compass in the fraternity. Otherwise the school itself may become an ingrown institution, and its student-government devices, its festivals and athletics for all, its swimming pools and dancing, its football fields and club houses, may become agencies of personal enjoyment outside the correctives of the moral and civic needs of the environing society.

The problem of the fraternity, consequently, is not to be settled by repression or arbitrary enactment. Its solution involves a progressive extension of the play attitude from gang to school and beyond—a play attitude which recognizes responsibility for more and more remote ends and abolishes the time-honored dualism of work and play. For the spirit of the creative artist is not confined to the fields of music, painting and the drama. In the professions, in industry and in politics, the men and women who have caught the contagion of play in their youth make their ideal enterprises enthusiastic, daring games, guided, however, by the standards of execution which they have learned on the playground.

WAGES AND SALARIES IN ORGANIZED INDUSTRY

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I. The Narrowed Range of Information

THE extreme differences between the various groups of gainfully employed people in the United States take from the term "employed" any fixed meaning. Occupation, sex, geographical district and the kind of industry, play havoc with any hope that the problem of service income might be reduced to simple terms and treated as a unit. It is manifestly impossible to look upon a man who is "gainfully employed" as having any particular income, since there is no fixed relation between the fact of employment and the amount of income which employment yields.

Any treatment of service income limits itself arbitrarily because of the lack of available facts. Professional people, people rendering personal services, and the small owner or independent producer necessarily are eliminated. Those engaged in personal service and professional work are gainfully employed in every real sense of the word; the small producer of flour, as an example, is a producer in the same sense that the employees in a great flour mill are producers. At the present juncture, income figures have been collected for none of these groups. All of them perform useful social functions, yet regarding them there is only meager information, and that, for the most part, of so unreliable a character as to preclude the possibility of its use in any study that purports to be scientific.

The data at hand do furnish an indication, though an incomplete one, of the way in which income is apportioned among that vastly important part of the gainfully occupied world which is engaged with the processes of organized industry. After all, it is in them that the most permanent interest must center. Outside of agriculture, they constitute the great majority of the population. They are the human part of that system of organized industry toward which the world seems to be moving; from their hands flows most of that stream of goods upon which society subsists; to them is committed the imperative task of feeding, clothing, housing and otherwise providing for the wants of mankind. Although agriculture can not be included in the analysis because of the extreme paucity of the information about agricultural income, nevertheless the data about organized industry are profoundly significant because they bespeak the income situation in the newest, and it is probably fair to say the coming form of industrial organization.

"Values to the extent of $100 are paid to 'labor' or in the form of 'compensation' or of 'wages and salaries.' How is this $100 actually divided up among those who participated in its production?" The answer to that question can not as yet be made final; to the careful searcher after truth it is far from satisfactory; yet those who have eyes to see will find in it many suggestions of the situation that will stand revealed when all of the facts in the case are made available for study.

The tentative answer as to the disposition of service income will indicate for the various classes of industries what the situation of the ordinary, or "modal," person is. Of course the answer will not cover individual cases. No general statement holds true of individual instances. It will, however, show for certain occupations the general scale of service incomes.

No one can overstate the danger of trying to deduce from a statement of averages, or other general ideas referring to a class of things or persons, the condition of individuals in that class. It does not follow because the average for machinists on a certain railroad is $1.90 per day that the machinists on that road all receive $1.90 per day. It does not even follow that any one machinist is receiving exactly $1.90 per day. Some are receiving more, and some less. The mathematical computation derived from these individual rates of daily wages yields the average, $1.90.

The average is, at best, a crude method for the statement of incomes. Convenient because of ease in handling, it is misleading in the extreme when employed for purposes of generalization. It bespeaks not instances, or laborers, or families, but abstract deductions from the relation existing between these highly humanized economic facts.

The classified wage is far more satisfactory as a method of statement than is the average wage. Instead of averaging the wages of all machinists and stating the result as $1.90, the statement is made in this form: "Of 100 machinists, 5 receive less than $1.50 per day; 12 receive from $1.50 to $1.74; 40 receive from $1.75 to $1.99; 20 receive from $2.00 to $2.24," and so on through the list. The result is a presentation of earners by groups in a way that tells the size of the group and the amount earned by each number. Out of 100, 40 earn from $1.75 to $1.99. That is a very different matter from saying that the average wage is $1.90. If care is taken, generalizations regarding types and tendencies may be made without doing too much violence to individual instances. These generalizations should, wherever possible, be based on classes, rather than on averages.

Classified wage figures do not permit of such ready generalizations. They do, however, decrease error. People have assumed that the steel industry is a very lucrative one because certain individuals have made millions in it, or that there is an abundant chance for rapid advancement in the railroad industry because certain railroad presidents came

up from the ranks. Neither inference is necessarily correct. Generalizations can be made safely only where the facts about the great mass of instances are known. One man has made a million in the steel industry; four fifths of his co-workers in the industry are paid less than $1,000 a year. Is the industry lucrative? One man rose from the ranks to be president of a great railroad system. There are a hundred thousand of his fellows still in the ranks. How much chance have these men to become president of the railroad? The time has come to cease crude generalizations, and, by an appeal to the facts, to discover, not the average, but the actual way in which service income is distributed among gainfully employed people.

The races of men always face the statistician with the stern demand that he render a quick, easily comprehensible generalization, even though it be from a few insufficient instances. "Be brief" is a dangerous behest for science to follow. It leads to falsehood and inexactness more often than it leads to truth. It often happens that the statistician must sacrifice brevity for the sake of accuracy.

II. Salaries and Wages

The first large fact encountered in the analysis of service income is the distinction between salaries and wages. Although this distinction is arbitrary, it is significant for two reasons. First, because the incomes of "officers" and "salaried employees" are often very much higher than the incomes of "wage-earners"; and second, because in a large number of important publications dealing with service income, the incomes of wage-earners alone are given, while in other cases the figures frequently contain statements for salaries and wages. In the main, the emphasis will be laid upon wages, first, as a matter of necessity. There is no analysis of compensation which shows salaries with the same minuteness that wages are set forth. Secondly, as a matter of choice. The wage-earners, being an overwhelming majority of the whole, constitute the bulk of the human income problem in industry.

The contrast between the amount paid to salary-earners and to wage-earners is in some cases considerable, and in others it is far less marked. Average figures alone are available for this comparison, because there is nowhere any statement of classified earnings for "officers." Although crude in the extreme, these averages give some idea of the divergence between "salaries" and "wages."

The Iowa Railroad Commission reports several instances in which the compensation paid to officers is not much greater than that paid to wage-earners. The general officers of the Iowa Terminal Companies[1] receive an average daily compensation for one company of $7.67, and for another company $4.38, while for the same companies the average

[1] Annual Report of the Board of Railroad Commissioners of Iowa, 1911, Des Moines, 1913, p. 498.

daily compensation of all other employees ranges from $1.95 to $2.55. The Iowa Bridge Companies[2] report an average daily compensation for general officers of $4.32, and for all other employees $2.01. These companies are small, and the variation between the returns to the officers and wage-earners is probably typical of that existing in many small businesses.

The railroads report a divergence between the compensation of general officers and of other employees which is considerable. For all operating railroads in the United States, the average daily compensation of general officers was $12.99[3] For Class I. roads (annual earnings over $1,000,000) the average is, in the Eastern District, $19.52; in the Southern District, $14.63; and in the Western, $16.63. In Class II. and Class III. roads the average is much lower. "The other officers" (there were in 1911 5,628 "general officers" and 10,196 "other officers" on all operating roads) received an average daily compensation of $6.27. For Class I. roads the average, as before, was somewhat higher than for Class II. and III. roads. Although the compensation rates for "other officers" do not greatly exceed the rates for the best-paid wage-earners, the rates of pay among general officers is much higher than for the wage-earners. With the exception of enginemen, conductors and machinists, no group of railroad employees receives an average daily compensation of more than $3.00 a day. For conductors and enginemen it is $4.16 and $4.79, respectively, and for machinists, $3.14. For most of the employees the average daily compensation ranges around $2.00. The same relation exists between the average wage of the great bulk of railroad employees and that of "other officers" as that shown for the Iowa Terminal and Bridge Companies. The compensation of the "general officers" on the railroads is very much higher.

Although the facts are most readily usable in the railroad industry, an examination of the figures from street and electric railways, mines and quarries, telegraph and telephone companies, and manufacturing industries tends to confirm the general impression made by the railroad statistics. For small concerns, and for second-grade officers, the rate of return is not greatly in excess of the rate for the better-paid wage-earners. The general, or first-class, officers who are responsible for large enterprises do receive, as a group, a rate of return which is ordinarily from five to ten times greater than the rate paid to wage-earners.

There is another point of great significance which must be borne in mind in this connection. The salaries of general officers are high in individual instances, nevertheless the aggregate of salaries paid is

[2] *Ibid.*, p. 516.

[3] Statistics of the Railways of the United States, 1911, Interstate Commerce Commission, Washington, Government Printing Office, 1913, p. 28.

small as compared with the entire amount of service income. Thus on the railroads the total compensation of both general and other officers was $40,000,000 in 1911. This constituted only about 3 per cent. of the total compensation paid during the year to all classes of employees. If to the salaries of all officers are added the total salaries of office clerks,[4] the entire salary schedule for the railroads covers 8 per cent. of the total amount paid in compensation.[5] The same situation exists in street railways. All street and electric railway salaries amount to approximately $13,000,000, which is 9 per cent. of the total amount paid for compensation.[6] The Census reports[7] the payment of $4,366,000,000 for services in the manufacturing industries. Of this amount, $939,000,000, or more than a fifth, was expended for salaries. Officers of corporations received a quarter of this salary expenditure; superintendents and managers another quarter, and clerks and other subordinate employees received a half. If individual industries are examined, however, it appears that in highly organized businesses like the production of iron and steel, of railroad cars and locomotives, of agricultural implements, and the like, the relation of salaries to total compensation is essentially the same as that for railroads. The figures for mines and quarries[8] show $40,000,000 paid in all kinds of salaries, as compared with $370,000,000 paid in wages. Again the figures appear as about 10 per cent. General officers received one fifth of the forty millions, or about 2 per cent. of the whole; superintendents, managers and foremen received three fifths, and clerks one fifth of the total salary expenditure. For those industries in which figures are available, it would seem that the general officers receive less than one twentieth of the total amount paid in compensation, while all salaried persons (general officers, other officers and clerks) receive about a tenth of the total payments in the form of compensation. This generalization holds true for large, highly organized industries. In the smaller, less specialized industries, the proportion which the salary account bears to the total payments for compensation is perhaps double that in the larger industries.

The figures furnish an indication of the manner in which service income is divided between those who receive salaries and those who receive wages. When a hundred dollars is paid in compensation by a

[4] This computation is made because of general usage by virtue of which clerks are paid by the month. Their yearly earnings are usually less than those of the better-paid wage-earners.

[5] *Ibid.*, p. 29.

[6] "Street and Electric Railways," 1907, Special Report of the Census, Washington, Goverment Printing Office, 1910, p. 195.

[7] Thirteenth Census of the United States, Volume VIII., Washington, Government Printing Office, 1913, p. 129.

[8] "Mines and Quarries," 1902, Special Report of the United States, Washington, Government Printing Office, 1905, p. 91.

modern large-scale industry, from 3 to 4 dollars go to general officers, from 6 to 10 dollars go to other salaried employees (including clerks), and the great bulk, from 85 to 90 dollars, is paid in the form of wages to wage-earners. This formula will not hold good for individual industries, but it does express with a considerable degree of fairness the situation now existing in organized industry. Furthermore, the fact should not be lost sight of that in more highly organized industries, that is, in the industries which have evolved to the point which virtually all industries may be expected to reach in the process of their development, at least ninety out of every hundred dollars paid for compensation goes in the form of wages.

The point regarding the distribution of compensation among salaried employees and wage-earners is not stressed. For the purpose of this study no importance attaches to the distinction between a wage and a salary, since both payments are made for "services." Nevertheless, since most of the available figures relating to service income are wage figures, the critical reader will bear in mind the fact that the necessity which forced the use of such material bears every earmark of reasonableness, since the bulk of service payments are made in the form of wages.

III. Incomes of Managers, Foremen and Other Officers

The data regarding the apportionment of incomes among officers of all grades are meager in the extreme. The mass of figures cited in the last section give some idea of the general relation existing between "salaries" and "wages" in bulk. They are of no value in an analysis of income apportionment among individual salary and wage-earners.

Figures showing the apportionment of income among general officers are apparently non-existent in any usable form. Even for under officials the figures are so scanty as to be worthy of only the most cursory analysis. The reason for this paucity of data is apparent. On the one hand, several of the most reliable sources (the reports of classified wages in the manufacturing industries of Massachusetts and New Jersey, for example) include "wage-earners" only in their classification. On the other hand, much of the salary information relating to under officials is, for all practical purposes, unclassified. The latest report of the California Bureau of Labor Statistics[9] is an excellent case in point. The income classification in that report includes, in its last category, incomes of $25 per week and over ($1,300 per year). For each city and under each industry "superintendents" or "managers" are listed, but in nine tenths of the instances they fall in this last class. That they receive more than $1,300 per year goes almost without saying. Exactly how much more the report does not state. The report

[9] Biennial Report for 1911–12, Sacramento, 1912.

might have stated with equal validity that the officials in California industries received in nine tenths of the cases over $1,300 annually.

The figures showing the service incomes of inferior officers on the railroads appear in the form of averages only. The section foremen, of whom there were 44,466 in 1911[10] received an average daily compensation of from $1.92 to $2.17, varying with the part of the country in which they were at work. The average daily compensation of general officers ($12.99) and of other officers ($6.27) has already been commented on. Apparently the railroad foremen receive a wage approximately the same as that paid to semi-skilled wage-earners. The compensation paid to officers is considerably greater.

One report[11] contains data of real importance in this connection. The most available figures in this report relate to the Bell Telephone System, from the 1908 pay rolls of which they were taken. Among the Bell employees there were 614 foremen, one fifth of whom received less than $80 per month ($960 per year), and eleven twelfths of whom received less than $125 per month ($1,500 per year). Of the total number, only 51 received more than $125 (the last class appearing in the report). The rates of pay for assistant foremen (39 in all) were much lower. Half fell below $80, and all but one below $125 per month. The pay of general foremen was higher. Of the 21 listed, half (10) received $125 or over per month. The managers and assistant managers were paid at approximately the same rate. Two fifths received less than $80, and four fifths less than $125. The pay of superintendents is much higher. There were only three under $80, and nine under $125. Three fourths (32 out of 41) received $125 or over.

The New York Public Service Commission reports upon the income rates of 635 foremen and assistant foremen employed by gas and electric utilities in the First District of New York. Only 2 per cent. received less than $750; 22 per cent. received less than $1,000; and 58 per cent. received less than $1,250.[12]

These figures are given rather because they emphasize the paucity of the data than because they serve any useful statistical purpose. So far as the figures go, they suggest that foremen, assistant superintendents and assistant managers are paid salaries about equal to those of the best-paid tenth among the wage-earners ($1,000 to $1,500 per year). Superintendents, general superintendents and general managers usually receive more than $1,500. It is to be hoped that before another income study is made there will be some authoritative state-

[10] Statistics of Railways, 1911, *op. cit.*, pp. 26 and 28.

[11] Investigation of Telephone Companies, United States Bureau of Labor, Senate Document 380, 61st Congress, 2d Session, Washington, Government Printing Office, 1910, pp. 273–89.

[12] Report of the Public Service Commission, First District of New York, 1911, Volume III., p. 275.

ment, at least for transportation agencies, showing the classified incomes of the men higher up.

IV. The Income of Clerks

There seems to be no very good reason why clerks should be classed among "salaried employees" rather than among "wage-earners," except that they are paid by the month. Nevertheless, they are so classed in virtually all of the reports, including the Census reports. For that reason they are so treated in this study.

The railroad industry may be passed by with a word of comment, since its figures take the undesirable form of "averages." The general office clerks[13] (30,613 in all) receive average daily compensations of $2.49. The uniformity of their compensation throughout the country is astonishing, in view of the usual variation in wages between the east and the west.[14] In the Eastern District they received $2.56; Southern, $2.39, and Western, $2.44. The other two groups of railway employees whose services might be classed as clerical are station agents (15,309 in 1911), and telegraph operators and dispatchers (14,857 in 1911). Their daily compensation is very uniform with that of the clerks. The average for the United States was: station agents, $2.17, and operators and dispatchers, $2.44. As in the case of the clerks, the rate of compensation varies only slightly from one part of the country to another. Apparently the salary rates of men doing clerical work in the railroad industry lie somewhere between $650 and $900 per year.

The statistics furnished from the telephone industry are worthy of some attention.[15] The total number of male clerks employed by the Bell system was 2,650. Of this number, one tenth received less than $40 per month, one third received less than $60, seven tenths received less than $80, and 52, or about 5 per cent., were paid more than $125. For the 257 male bookkeepers the facts show a slightly lower range. Only three received over $125, while four fifths received less than $80. Apparently in the telephone industry, as represented by the Bell interests, the bulk of the male clerical force is paid from $600 to $1,000 per year.

The female employees of the Bell system who were engaged in the work of clerical grades are compensated at a rate much lower than that for males. A little more than half (1,015) of the 1,862 female clerks were paid less than $40 per month, while nineteen twentieths were paid less than $50. The female "operators," who comprise the great bulk of telephone employees, report similar wages. The telephone company, employing 16,229 operators, paid seven eighths of them less

[13] Statistics of Railways, 1911, *op. cit.*, pp. 26 and 28.

[14] "Wages in the United States," Scott Nearing, New York, Macmillan Co., 1911, Chapter 8.

[15] Investigation of Telephone Companies, *op. cit.*, pp. 273–89.

than $40 per month, and all but 9 of them less than $60 per month. The 377 female stenographers received somewhat higher wages. Only a seventh fell under $40, two thirds under $60, while 19 earned over $80. Most of the female clerical force employed by the Bell system received less than $500 per year. A few were paid more than $700. The Public Service Commission of the First District of New York[16] gives some excellent figures for the public utilities. The street railways employ[17] 423 male general office clerks, for whom the wage rates are under $500 per year in 8 per cent. of the cases, under $750 in a quarter of the cases, and under $1,000 in three quarters of the cases.[18] The wage rates for the gas and electric utilities are very similar. Among 1,515 male clerks and salesmen, half received less than $750, and nine tenths under $1,250. The ratio is similar for other clerical employees. For cashiers and bookkeepers the rate is higher.[19]

The pay of females doing clerical work in all of the New York public utilities is very much lower than that of males. The street railway general office clerks receive less than $750 in four fifths of the cases. Among the 252 clerks and salesmen employed by the gas and electric companies, 210 received less than $750, and 240 less than $1,000 a year. The rate for stenographers and typists is somewhat higher, one in ten of them receiving over $1,000 a year.

Little information is available dealing with the salaries of clerks in manufacturing industries. The Census reports the employment in the manufacturing industries of 576,356 "clerks and other subordinate salaried employees."[20] The total salaries paid to this group was $497,998,101.[21] The absence of any statement regarding sex invalidates any analysis of the figures.

The female clerical help employed in Washington, D. C., in de-

[16] Annual Report of the Public Service Commission of New York, First District, 1911, Volume II.

[17] For convenience of comparison, the figures given in the remainder of this study are stated, for the most part, in the following classification:

Per Cent. of Persons Receiving Wage Rates Per Year of	Less Than
	$250
	$500
	$750
	$1,000

The percentage basis is substituted for the numerical basis because it results in greater clearness. The classification per year rather than month, week, or day, is adopted, because the figures appearing in the reports as rates per hour, day, week and year, can be reduced to a rate per year more readily than to any other rate. Observe that these figures do not represent earnings per year. No allowance is made for unemployment in any of its forms. The rate per week or per month is multiplied by 52, or by 12, in order to give a year rate. The reduction of all of the figures to a common basis militates somewhat against their accuracy (as when a per hour rate is converted into a yearly rate), but adds greatly to their clearness.

[18] *Ibid.*, p. 334.

[19] *Ibid.*, pp. 272–74.

[21] *Ibid.*, p. 129.

[20] General Report on Manufactures, Thirteenth Census, Volume VIII., p. 239.

partment stores (252 in all) received in a fifth of the instances less than $250 per year, and in four fifths of the instances less than $500 per year.[22]

Although these figures showing the wage rates of clerks are meager in the extreme, they are sufficiently extensive to permit of a tabular statement that will bring out the likenesses and differences existing among them.

TABLE I

SALARY RATES OF MALE CLERKS IN CERTAIN INDUSTRIES

Industry and Occupation	Total Number Employed	Per Cent. of Male Clerks Receiving Wage Rates per Year of Less Than			
		$500	$750	$1,000	$1,250
Bell Telephone System (clerks)	2,650	9	36	71	95
New York Street Railway (general office clerks)	423	8	27	74	.....
New York Gas and Electric Utilities (clerks and salesmen)	1,515	9	47	76	91
Other clerical employees	440	22	57	85	93
Cashiers and bookkeepers	587	2	5	48	83

TABLE II

SALARY RATES OF FEMALE CLERKS IN CERTAIN INDUSTRIES

Industry and Occupation	Total Number Employed	Per Cent. of Female Clerks Receiving Wage Rates Per Year of Less Than		
		$500	$750	$1,000
Telephone clerks	1,852	54	95	99
Telephone operators	16,129	87	99	.....
Stenographers	377	13	60	96
New York Street Railway	154	66	85	99
New York Gas and Electric Utilities (clerks and saleswomen)	252	29	83	95
Stenographers and typists	209	14	59	89
Washington department stores	252	23	82	.....

Those clerical occupations for which data are available pay wages at a rate that does not differ materially from the ordinary wage rates of semi-skilled and skilled labor. Three quarters of the male clerks receive less than $1,000 per year, while less than 10 per cent. are paid more than $1,250. For females the rates are much lower. The proportion of women who receive less than $750 for clerical work is approximately the same as the proportion of men who receive less than $1,250. The woman in a clerical position who receives more than $1,000 is the exception, just as the man who receives less than $500 is the exception. At the same time, a large percentage of the women receive less than this figure, while a considerable proportion of the men receive more than $1,000. In only a small proportion of the instances

[22] "Hours, Earnings and Employment of Wage Earning Women in the District of Columbia," United States Department of Labor, Bulletin 116, Washington, Government Printing Office, 1913, pp. 22 and 23.

does the wage rate among male clerks rise above $1,250; in an even smaller number of instances do wage rates of female clerks rise above $750.

V. The Income of Wage-earners in Transportation and Commerce

One of the most unsatisfactory situations which an analysis of wage statistics reveals, is the paucity of the wage figures relating to transportation and commerce. It is in these fields that inquisitorial bodies have the greatest authority; yet it is in these fields, strangely enough, that the wage statistics are least satisfactory. With the exception of the Census volumes for 1912 on express, and telephone and telegraph, and of a special report by the Bureau of Labor on the telephone industry, there is little or nothing of note.

The wages in the railroad industry, employing as it does more than a million and a half persons, are stated only as averages. The excuse for this statement of railroad wages in terms of averages—it requires some excuse, for, though the averages are given by districts and for ten wage-earning occupations and two groups of miscellaneous wage-earners, these again classified by districts and by the class of railroads, they are still averages, and therefore suffer under all of the disqualifications that averages are heir to—seems to be that the length of time and the conditions of the work done by different employees vary so greatly that no classified statement could do justice to the situation. Pursuant of such philosophy the Interstate Commerce Commission has done, under the circumstances, the most misleading thing that it could possibly have done—that is, it has published averages; and the State Railroad Commissions, following the footsteps which, unknown to them, led so directly into this statistical quagmire, also have published nothing but averages.

Granted that, in the case of railroad employees, the classified or group system of stating wages is inaccurate, how much more inaccurate does the average become? Instead of accepting errors at their face value, the average thus obtained compounds and augments error. Nor is this a case in which errors tend to neutralize each other. What avails an average of the wages of switch tenders in Maine and in Ohio? What avails an average wage for "all other employees and laborers," including for the United States nearly a third of a million men? The method carries its own refutation. Except as a basis of comparison from year to year, the figures are meaningless and absurd.

The difficulties lying in the path of obtaining classified wages for railroad employees do not seem to be so great as the protestors claim them to be. Why should not the Interstate Commerce Commission secure from each railroad a statement for the first week in June and December showing the number of employees of each class who had

earned during that week less than $5, $5 but less than $6, $6 but less than $7, $7 but less than $8, and so on through the category? If the system of payment by months is so prevalent as to make the weekly statement impossible, a statement for an entire month would be even more satisfactory than a statement for a week only. The time would be longer and the results more representative.

At this point it must suffice to say that the average figures for wages on American railroads seem, for the most part, typical of the average wages reported in the manufacturing and other like industries. With the exception of enginemen, conductors and machinists (who constitute 9 per cent. of the total number of employees, and whose wages average in the first two cases over $4, and in the last over $3), no group of employees reports an average wage of more than $3. For three groups the average is less than $2; for three groups it is between $2 and $2.49, and for three other groups it falls between $2.50 and $2.99. An analysis of average wages in those manufacturing industries which are similar in character to the work done on the railroad, shows that the averages are approximately similar.[23] With the exception of the three high-paid occupations mentioned above, railroad wages are, to all appearances, on a level with other wages in the community.

The telephone and telegraph industry offers some excellent wage data. The Oklahoma Department of Labor publishes some figures on wages in the telephone industry. Of 660 male wage-earners, 27 per cent. received less than $500; 78 per cent., less than $750, and 95 per cent. less than $1,000. The wage rates for females are much lower. There were 1,143 employed. The wage rates of 17 per cent. were under $250, 96 per cent. under $500, and 99 per cent. under $750.[24]

The wage figures published by the Bureau of Labor[25] are taken from the pay rolls of the company, and represent, as accurately as wage figures may, the situation on the company's books in 1908. In general, the wage scale in the telephone industry is much higher than the scale in most other industries.[26] The wages in nine typical occupations (cable splicers, chauffeurs, drivers and stablemen, installers, inspectors, laborers, repairmen, switchboard men, testers and trouble men) show a considerable uniformity.[27] Only 10 men (they were all in one class, "inspectors") were receiving wages of more than $125 per month ($1,500 per year); two fifths received less than $750; four fifths received less than $1,000. If the laborers are eliminated, the range for the other occupations is greatly advanced. The great bulk of installers,

[23] "Wages in the United States," *op. cit.*, Chapter 7 and Chapter 9, Section II.

[24] Annual Report of the Department of Labor of Oklahoma, 1911–12, p. 232.

[25] Investigation of Telephone Companies, 1910, *op. cit.*

[26] "Wages in the United States," *op. cit.*, pp. 96–108.

[27] Investigation of Telephone Companies, *op. cit.*, pp. 273–289.

inspectors, repairman, switchboard men, testers and trouble men earn from $750 to $1,000.

The figures for transportation and commerce permit of no further generalization than this—so far as the data at hand may be relied upon, those occupations which have counterparts in manufacturing industries apparently pay about the same rate of wages. At the same time, there are in this field a number of highly skilled occupations which pay wages far above the usual run of wage rates. Even in these high-paid occupations, however, only a small proportion of male employees receive over $1,000; about an equal proportion of female employees receive over $750. Here and there a male employee is paid over $1,500 per year, and a female employee over $1,000 per year. These cases are so rare as to be unique.

VI. The Income of Wage-earners in the Mercantile Industry

The wage figures for the mercantile industry are even less conclusive than those for transportation and commerce. Their inconclusiveness has far more excuse for existence, however. Until recently the mercantile industry has been conducted on a small scale. The individual proprietor is still the dominating force in many fields. In no sense have the mercantile trades been organized as the railroads and the steel industry are organized. At the same time, organization is becoming the rule of the road, and the mercantile industry is rapidly shaping itself into a highly developed business. Meanwhile, the meager data on wages in the mercantile houses are indicative, though not in any sense conclusive.

The last report from California gives in elaborate detail the facts regarding the wholesale and retail mercantile establishments.[28] Although the figures are scattering, a summary for San Francisco and Los Angeles (the two chief mercantile centers) gives the following results for male employees.

The contrast between the wages of males and of females is sharp indeed. While only a tenth of the males receive less than $500 per year, and only a third less than $750, a tenth of the females in retail establishments receive less than $250; from a fifth to two fifths receive less than $500; and from three fifths to four fifths fall under $750.

The wage rates for both sexes are higher in wholesale than they are in retail establishments. This is more true in the case of males than of females, although it is striking in both instances. It is also interesting to observe that the wage rates in San Francisco do not differ materially from those of Los Angeles.[28a]

[28] Biennial Report for 1911–12, Sacramento, 1912. Figures compiled from the tables.

[28a] The reader should bear in mind the fact that wages in California are perhaps a fifth or a fourth higher than wages for corresponding occupations in the East.

TABLE III

WAGE RATES OF MALES, CALIFORNIA, 1911

Retail Establishments

	Total Employed	Per Cent. of Employees Earning Wage Rates Per Year Less Than			
		$250	$500	$750	$1,000
San Francisco	5,389	4	14	29	57
Los Angeles	6,277	3	10	37	71

Wholesale Establishments, Males

	Total Employed	Per Cent. of Employees Earning Wage Rates Per Year Less Than			
		$250	$500	$750	$1,000
San Francisco	8,300	1	7	23	52
Los Angeles	4,820	.....	6	29	51

The Massachusetts Commission on Minimum Wage Boards reports on the wages of 3,761 women and on the annual earnings of 1,533 who were employed throughout the year. Many of the department-store employees not employed throughout the year leave for new positions, or are laid off in the dull season. All but 33 of the 1,533 women employed throughout the year earned less than $500 per year. The hour rates of all of the 3,761 women show practically the same ratio.

Two other sources of information yield similar results. A well-made study of saleswomen and other mercantile employees, not including buyers or clerical assistants, was made in Baltimore by Elizabeth B. Butler. The total number of women covered by the investigation was 4,048. Of these women, 2,184, or 54 per cent., received a rate of pay of less than $250 per year, while 95 per cent. were paid less than $500.[29] These rates are apparently slightly below the rates in Washington. Among 1,760 saleswomen in the Washington stores, a quarter received less than $250, while less than nine tenths fell below $500.[30] Comparative studies indicate that the department store employees are paid at a higher rate than factory employees. Unfortunately the variations of age between the two occupations have not generally been taken into account. An Illinois investigation covering 2,556 department store employees showed that a twentieth received less than a $250 wage rate, and half less than a $500 year rate. On the other hand, a fifth of the wage rates were over $750.[31]

It seems evident that for most saleswomen in eastern mercantile

[29] "Saleswomen in Mercantile Stores," E. B. Butler, Baltimore, 1909, New York, Charities Publication Committee, 1912.

[30] "Hours, Earnings and Employment of Wage-earning Women in the District of Columbia," *op. cit.*, pp. 22 and 23.

[31] Biennial Report of the Bureau of Labor Statistics, Ill., 1908, Springfield, 1910, pp. 413–592.

stores, wage rates of more than $500 per year ($10 per week) are out of the question. The great bulk of them are paid from $250 to $500.

VII. The Incomes of Wage-Earners in Certain Manufacturing Industries

Whatever their failure to provide adequate statistics covering wages in other gainful occupations, state and federal authorities have vied with one another in their efforts to prepare wage statistics for the manufacturing industries. The figures are as yet far from complete; there are still many loopholes through which unjustifiable conclusions may slip unaware; yet, all things considered, the wage figures for the manufacturing industries are far superior to those for other occupations. They point the way, showing what may be done in the compilation of wage data.

Convenience leads to a grouping of the figures for manufacturing industries into three classes. Those for special industries, such as steel, textiles, etc.; and those for certain states which publish the best wage statistics; and those published by the Census.

The past three years have added materially to the statistics for special industries. The public demand for facts which arose out of labor disturbances, and the activity of certain public commissions vested with inquisitorial power, have led to the collection of considerable wage data of the greatest value. These data are peculiarly important because in many cases the investigation has been made from the pay rolls of the company or industry in question. In certain cases these pay-roll data have been extensively compared with pay envelopes. The purpose of this section will be served by a review of only the most important of the recent wage investigations.

The most complete, and in all ways the most satisfactory, of the recent studies is that of the iron and steel industry, appearing in four volumes.[32] Each occupation in the steel industry was carefully studied. The investigation included plants in every part of the country, and was minute and painstaking in the last degree. In so far as the wage figures are important at this point, they may be briefy summarized as follows: The investigation covered 172,706 employees; their wage rates per year (computed from the per hour rates given for May, 1910) were, under $500, 8 per cent.; under $750, 60 per cent.; under $1,000, 85 per cent.; and under $1,500, 97 per cent.[33] These rates are somewhat higher than the rates previously derived for Bethlehem,[34] where the wage rates for

[32] Report on Conditions of Employment in the Iron and Steel Industry in the United States in four volumes, 62d Congress, 1st Session, Senate Document 110, Washington, Government Printing Office, 1912.

[33] Summary of Wages and Hours of Labor in the Iron and Steel Industry, United States Department of Labor, Senate Document 301, 62d Congress, 2d Session, Washington, Government Printing Office, 1912.

[34] "Wages in the United States," *op. cit.*, pp. 108–112.

that one plant were (January, 1910) in a third of the instances less than $500 per year, in two thirds of the instances less than $625, and in only 8 per cent. of the instances $1,000 and over. In explaining this difference allowance must be made for the fact that the Bethlehem works are in a small city, while many of the plants are located in great centers of population.

Although the wages in the iron and steel industry are higher than the wages paid in many American industries, they seem fairly representative of the situation in those branches of manufacturing which afford employment to men only. In the industry where women as well as men are employed, the wage scale is lower. The wage formula for the steel industry may be taken as a representative of the man-employing industries.

Labor troubles and tariff controversies have combined to attract public attention to the wage rates paid in the textile industries, consequently the data for these industries are now fairly well authenticated. The Tariff Board made an extensive investigation of wage rates in the cotton industry.[35] The information, secured from 76 establishments, covered 18.67 per cent. of all cotton spinning and weaving employees enumerated by the Census (p. 633). An arbitrary division between the northern and southern mills draws a line of marked distinction as to wages. Among the males sixteen years of age and over, in the north 5 per cent., and in the south 22 per cent., received a wage of less than $250. Half of the northern men and over four fifths of the southern men were paid at a rate of less than $500 per year. The highest wage rate in the schedule was twenty-eight cents per hour (about $750 per year). In the north 6 per cent., and in the south 3 per cent., earned more than this amount. The figures for women range much lower than the figures for men. The highest class in the women's schedule is eighteen cents per hour (about $500 per year). In the north, one fifth, and in the south, two per cent., receive more than this amount.

These rates for the cotton industry are similar to those for the woolen and worsted industry. The Tariff Board reports for dyeing and finishing woolens and worsteds[36] that the wages of male dyers are in four fifths of the cases under $500, and in nine tenths of the cases under $700. The highest wage class given in this schedule is twenty-five cents per hour (about $700 per year). Eight per cent. of the male dyers, 15 per cent. of the male finishers, and 3 per cent. of the female finishers received wage rates above that amount. This investigation is obviously faulty in the comparatively small proportion of the employees

[35] Report of the Tariff Board on Cotton Manufactures, 62d Congress, 2d Session, House Document 643, Washington, Government Printing Office, 1912, Volume II., pp. 637–651.

[36] Report of the Tariff Board on Schedule K, House Document 342, Washington, Government Printing Office, 1912, Volume II., pp. 810–811.

included. It is suggestive, however; and corroborated as it is by the records of other investigations, it must go almost unchallenged.

The report on the wages in the woolen, worsted and cotton mills of Lawrence, Mass.,[37] (November, 1911) is corroborative, for one town, of the general situation as suggested by the Tariff Board's general report. Half of the men received a wage rate of less than $500; seven eighths, of less than $600. More than four fifths of the women fell in the group under $500, and 94 per cent. received less than $600. The schedule grouped all earnings above $600 in one class. These figures represent the actual earnings of males and females eighteen years of age and over during one month in 1911.

Similar wages were compiled for the textile mills (largely hosiery mills) of Little Falls, N. Y.[38] These figures represent actual earnings during parts of September, 1912. Among the total of males employed, three fifths earned at the rate of less than $500, while nine tenths earned at the rate of less than $750 per year. Of the 2,736 women, 99.8 per cent. earned at the rate of less than $750 per year, while three quarters fell below $500. This period under investigation is described by the report as one of normal working conditions.

The inferences from these figures for special towns are corroborated, in large measure, by the special publication of the United States Department of Labor, dealing with the textile industry. These figures, while incomplete and open to question because of the uncertainty as to the manner in which the factories and employments under consideration were selected, are nevertheless suggestive of the general situation. In the cotton industry, three fifths of the males, and four fifths of the females received wage rates of $500 per year; while 97 per cent. of the males, and 99 per cent. of the females had wage rates of less than $750 per year.[39] The wage rates in the woolen industry are considerably higher, though at about the same level as that for the special reports. The wage rates reported for the textile industries in Massachusetts and New Jersey amply confirm the results derived in these special investigations.

The textile industries show an unusually low scale. Practically none of the men receive more than $1,000; with the exception of woolen finishers, only a tenth receive more than $750. Among the women the rates are even lower. For them a wage over $750 is not

[37] Report on the Strike of Textile Workers in Lawrence, Mass., Charles P. Neill, Senate Document 870, 62d Congress, 2d Session, Washington, Government Printing Office, 1912.

[38] "The Little Falls Textile Dispute," New York State Department of Labor, Advance Report of the Bulletin for March, 1913, Albany, 1913, pp. 10–11.

[39] "Wages and Hours of Labor in the Cotton, Woolen and Silk Industries," United States Department of Labor, Bulletin 128, Washington, Government Printing Office, 1913, pp. 30–34.

found much oftener than once in a hundred times, while a wage of less than $500 is paid in three fourths or four fifths of the cases.

Although so many data have been compiled for textiles, the other industries have not been neglected. A number of wage figures are available for lumber and kindred industries. The Tariff Board published a report on the wages for certain selected occupations in the paper industry,[40] and the Bureau of Labor has a study of wages in the lumber and furniture industries. The men employed in the paper industry receive rates of less than $750 in four fifths of the instances, and of less than $1,000 in nineteen twentieths of the instances. The wage rates in the lumber, millwork, and furniture industries are approximately the same as those for pulp and paper, although lumber falls lower than either of the other two. Two fifths of the men in the lumber industry receive less than $500 per year; nine tenths receive less than $750. Millworkers receive less than $750 in three fifths of the cases, and less than $1,000 in three fourths; while furniture makers (male) receive less than $750 in half of the cases, and less than $1,000 in nine tenths of the cases.

The data presented by the Department of Labor for the clothing industry are so meager as to be almost unusable. The total number of persons included in the statement is six thousand women, and seven thousand men.[41] Since there is no certainty as to the manner in which the selection was made, and since there is little or no corroborating evidence, the material must be passed over.

The study of wages in the cigar industry, which the Department presents, is somewhat more illuminating, because it is more careful and detailed.[42] Still, the number of employees for whom evidence is submitted is woefully small. Among the 3,615 males, three tenths received a wage of less than $750, and half a wage under $1,000. Four fifths of the 7,551 females received less than $750. Any one who takes the pains to examine these figures can not help feeling that they do not adequately represent the cigar industry.

An interesting analysis of the work of women in the finishing department of the glass industry appeared in connection with the study of "Woman and Child Wage-Earners." The study, which covered the glass industry with a degree of thoroughness, shows 2,774 women engaged in finishing, for whom satisfactory data could be secured. The chief interest in these figures lies, not in the wage scale which they reveal—there is nothing unusual in that—but in the fact that Mr. Manly, in making the study, procured for this group of women the

[40] Report on Paper and News-print Paper Industry, 62d Congress, 1st Session, Senate Document 31, Washington, Government Printing Office, 1911, p. 111.

[41] "Wages and Hours of Labor in the Cigar and Clothing Industries, 1911 and 1912," United States Department of Labor, Bulletin 135, Washington, Government Printing Office, 1913, pp. 25–80.

[42] *Ibid.*, pp. 5–25.

actual earnings, as well as the wage rates. Thus far, in the course of this study, wage *rates* have been considered almost exclusively, and the yearly rate has been derived by multiplying the weekly wage rate by fifty-two, and the monthly wage rate by twelve. Under these circumstance, no allowance is made for loss of time due to sickness, shortage of orders, and other causes of unemployment. The following table for the glass industry makes the contrast in excellent form:

TABLE IV

EARNINGS OF WOMEN IN THE FINISHING DEPARTMENT OF THE GLASS INDUSTRY[43]

	Total Employed	Earnings per Year of Less Than		
		$250	$500	$500 and Over
Full time	2,774	38.9	97.4	2.6
Actual earnings	2,774	56.5	98.1	1.9

The wage scale shown by this table for the glass industry would lead one to conclude that two fifths of the women were receiving less than $250 per year. As a matter of fact, the proportion of women whose earnings were less than $250 per year was nearly three fifths. Deductions in one form or another nearly always drag a wage scale considerably below its face value.

The wages actually paid in the Chicago slaughtering and meat-packing industry are given in a most satisfactory way by J. C. Kennedy in a recent study. Mr. Kennedy obtained access to the pay rolls, and was thus able to discover the wages actually paid during a long period. The figures are peculiarly interesting, relating, as they do, to one of the chief centers in which one of the great industries in the country is carried on. It is, indeed, difficult to overemphasize their importance as portraying the present income situation in a leading industry.

TABLE V

WEEKLY WAGES ACTUALLY PAID IN CERTAIN PACKING PLANTS OF CHICAGO[44]

	Total Employed	Per Cent. Receiving Wages per Year of Less Than			
		$250	$500	$750	$1,000
Males	7,096	12	39	83	96
Females	1,064	27	92	99	..

A quarter of the women and a tenth of the men are paid less than a $250 rate; two fifths of the men and nine tenths of the women fall under $500. These figures would be further modified if they made allowances for unemployment throughout the year. As they stand they are the result of a simple process of multiplication.

[43] "Woman and Child Wage-earners in the United States," Charles P. Neill, Washington, Government Printing Office, 1911, Volume III., p. 405.

[44] "Wages and Family Budgets in the Chicago Stock Yards District," J. C. Kennedy, Chicago, University of Chicago Press, 1914, p. 12.

The wage rates for the manufacturing industries are, for convenience, summarized in Tables VI. and VII. Practically all of the figures show wage rates rather than earnings.

TABLE VI

COMPENSATION WAGES FOR MALE WAGE-EARNERS IN CERTAIN MANUFACTURING INDUSTRIES

	Total Employed	Per Cent. of Males Receiving Wage Rates Per Year of Less Than					
		$250	$500	$750	$1,000	$1,250	$1,500
Iron and steel industry (1910)	172,706	....	8	60	85	.....	97
Textiles—cotton (1910–11),							
North	11,041	5	54	94	.....	.....	.....
South	3,784	22	85	97	.....	.....	.....
Woolen and worsted (1910–11),							
Dyeing	791	....	87	92	.....	.....	.....
Finishing	1,644	2	76	85	.....	.....	.....
Lawrence (1911)	11,075	5	56	....	.....	.....	.....
Little Falls (1912)	2,502	7	63	87	96	.....	.....
Woolen (Bureau of Labor 1910–11)	17,178	1	30	77	97	.....	.....
Cotton (Bureau of Labor 1910–11)	28,478	8	57	97	.....	.....	.....
Pulp and paper industry (1910)	9,173	....	32	83	94	96	96
Lumber (1910–11)	59,228	....	39	91	96	.....	99
Mill work (1910–11)	32,405	....	14	57	74	.....	98
Furniture (1910–11)	34,095	....	10	47	93	.....	99
Cigar (1910–11)	3,615	....	6	29	53	.....	96
Meat packing (1910–11)	7,096	12	39	83	96	.....	.....

TABLE VII

COMPENSATION RATES FOR FEMALE WAGE-EARNERS IN CERTAIN MANUFACTURING INDUSTRIES

	Total Employed	Per Cent. of Females Receiving Wage Rates Per Year of Less Than			
		$250	$500	$750	$1,000
Textiles—cotton (1910–11)					
North	12,424	9	81	.....	.....
South	2,337	47	97	.....	.....
Woolen and worsted (1910–11), Finishing	2,886	13	86	97	.....
Lawrence (1911)	8,320	8	86	.....	.....
Little Falls (1912)	2,736	13	78	99.8	.....
Woolen (Bureau of Labor 1910–11)	18,144	5	53	97	.....
Cotton (Bureau of Labor 1910–11)	38,445	19	83	99	.....
Cigar (1910–11)	7,551	11	44	86	96
Glass finishing (1909)	2,774	39	97	.....	.....
Meat packing (1910)	1,064	27	92	99	.....

There is every difficulty in the way of generalizing from these scattered instances. On the face of the returns, the wages for men are much higher than the wages for women. Both appear distributed over the wage scale in varying proportions, depending upon the industry. With the exception of the finishing departments of the woolen mills, the wages paid in the textile industry appear to be lower than those paid in any other of these industries; the wage rates fall in the vast majority

of instances for the men, under $1,000, and for the women, under $750. In most industries, from a third to a half of the men receive less than $500; and usually at least three quarters receive less than $750. Four fifths of the women are paid less than $500. Women working in the manufacturing industries receive, for the most part, wages varying from $250 to $500.

VIII. Wage Rates Paid in the Manufacturing Industries, as Reported by Certain States and by the United States Census

Much emphasis has been placed upon the wage figures derived in the course of special wage investigations, because in most cases these figures represent actual conditions at a definite time. There remain the general figures for manufacturing industries published by certain states and by the United States Census Bureau. In neither case do these figures materially alter the conclusions which were derived as a result of the study of special wage investigations.

The wage facts secured by many states are grossly inadequate.[45] Nevertheless, there is a growing body of usable information relative to the wage scales paid in certain states. As regards the excellency of their figures, New Jersey and Massachusetts are well in the lead. Several other states are making strenuous efforts to duplicate or better their good work.

The state wage figures are usually given in two forms. First, in the form of wages for the entire state; and second, in the form of wages for certain industries. Several states present, in addition, wages for the larger cities. The figures for the entire state are meaningless in one sense, because of the great diversity of industries. In another sense, they are profoundly significant. The wage statistics, for example, of Massachusetts show for six hundred thousand men and women (out of a total population of 3,366,416 in 1910) what the wage scale is in the manufacturing industries. There could be no more effective metrical test applied to the community, unless the actual family incomes were measured. The wage scale for the manufacturing industries of a manufacturing state shows at least roughly the economic background of the people living in the State. For both New Jersey and Massachusetts, two of the six leading manufacturing states, there are extant sufficient wage figures to paint the economic background of the great body of the industrial population in these states.

An examination of the figures for various states, and for all of the leading industries of the country, corroborates the conclusions already made from the special reports. The wage rates are such that, making no allowance for unemployment, about one tenth of the males receive more than $1,000 per year, and about one eighth of the females more than $500 per year. At the same time, from a quarter to a third of

[45] "Wages in the United States," *op. cit.*, Chapters 1 and 2.

the males receive less than $500 per year, and from a tenth to a fifth of the females receive less than $250 per year. Thus the great bulk of the males are paid wage rates varying from $500 to $1,000, while the great bulk of the females are paid wage rates of from $250 to $500. To this general statement, Oklahoma and California are exceptions. The wage rates there are considerably higher than in the east.

The figures for the manufacturing industries, in the states compiling such figures, include practically all of the persons occupied in the manufacturing industries within a given state. The Census figures include only a fraction of the employees engaged in the manufacturing industry. The Census figures are interesting chiefly because they include a wide geographical range. They virtually cover an industry for the entire country. They differ in no essential particular from the conclusions already derived from the state and special wage figures.

IX. The Income of Wage-Earners Engaged in Public Utilities

Recent studies have made available a few figures which show the scale of wages paid by public utilities. These wages are higher than the wages for industry in general, but they are not materially higher than the wages paid in the other man-employing industries.

Three states (New York, Oklahoma and Kansas) publish wage rates for public utilities. The New York figures are for the First District. There were in 1911 38,139 employees on the street railways of the First District. Of this number the wages of 9,635 men employed by "selected" companies are tabulated. Of the total, 5 per cent. received less than $500 per year; two fifths received less than $750; and nine tenths received less than $1,000.[46] The gas and electric companies in the same district report the employment of 16,741 men, for whom the range of wages is considerably higher than the range for street railway employees. Eight per cent. were receiving wage rates under $500, 45 per cent. under $750, three quarters under $1,000, and nine tenths under $1,250.[47]

The figures for the two Western States differ little from those for New York. The Oklahoma report, covering 1,129 adult males engaged in public utilities, gives the wage rates for two thirds as under $750, and nine tenths as under $1,000.[48] In Kansas, of the 702 adult males reported as employed, three quarters received less than $750, and 95 per cent. less than $1,000.[49]

The compensation rates of persons employed in public utilities are fairly uniform. These occupations apparently range among the better-

[46] Annual Report of the Public Service Commission of New York, *op. cit.*, pp. 334–339.

[47] *Ibid.*, Volume III., pp. 280.

[48] Annual Report of the Department of Labor, Oklahoma, 1911–12, p. 209.

[49] Annual Report, Kansas Bureau of Labor, 1909, Topeka, 1910, p. 21.

paid occupations of the country. The following summary shows the available figures:

TABLE VIII

COMPENSATION RATE FOR MALE WAGE-EARNERS IN PUBLIC UTILITIES

	Total Employed	Per Cent. of Males Receiving Wage Rates per Year of Less Than			
		$500	$750	$1,000	$1,250
New York (First District),					
Street Railway	9,635	6	42	89	.....
Gas and Electric	16,741	8	45	76	88
Oklahoma	1,129	7	65	89	.....
Kansas	702	24	74	95	.....

X. THE WAGE RATES FOR MINES AND QUARRIES

The volume of the Thirteenth Census devoted to mines and quarries omitted any statement of classified wages. The only general data on the subject appear in the special Census report on mines and quarries issued in 1902.[50] The data contained in this volume are now so thoroughly out of date that only a brief reference to them will be made.

There were in 1902 581,728 wage-earners engaged in the production of all forms of minerals. The wage rates per day of these men are given by industries, by occupations, and by geographical divisions.

The tables showing the classified earnings of all wage-earners in the mining industry report 16 per cent. of the men as receiving less than $1.74 per day ($500 a year); 62 per cent. received less than $2.49 per day ($750 per year); and 93 per cent. received less than $3.49 per day ($1,050 per year). This showing, on its face, makes the wage scale in the mining industry correspond rather closely with that in the manufacturing and mercantile industries.

One further fact of the greatest significance must be borne in mind, —the ratio of unemployment in the mining industry, particularly in the coal-mining industry, is comparatively high.[51] The federal report on the production of coal in 1910[52] shows an average number of days worked in the bituminous coal mines of 217 out of a possible 306, and in the anthracite coal mines of 229 out of a possible 306 days. Under the circumstances it is not fair to make a direct comparison between the wage rates in manufacturing and in mining, derived by multiplying the day rate by 306. The proportion of unemployment, particularly in the coal mining industries, is very much higher.

Almost one half of the total number of persons employed in mining in 1902 were in the bituminous coal mines. Of the bituminous coal

[50] Washington, Government Printing Office, 1905, pp. 90–101.

[51] "Unemployment in the United States," Scott Nearing, Quarterly Publications of American Statistical Association, Volume II., September, 1909, p. 534.

[52] "Mineral Resources of the United States," Washington, Government Printing Office, 1911, p. 41.

miners, 280,638, only 9 per cent., were paid less than $1.75 per day; 20 per cent. were paid less than $2.00 per day; 58 per cent. were paid less than $2.50 per day; and 95 per cent. were paid less than $3.50 per day. The rates of pay for anthracite coal mining (employing 69,691 men) were very much lower than the rates for bituminous coal mining. Thirty-one per cent. of the anthracite coal miners received less than $1.75 per day; 46 per cent. received less than $2.00 per day; 74 per cent. received less than $2.50 per day; and 95 per cent. received less than $3.50 per day.

The production of iron ore involved the employment of 38,851 men. These were paid less than $1.75 in 22 per cent. of the cases, less than $2.00 in 37 per cent. of the cases, less than $2.50 in 78 per cent. of the cases, and less than $3.50 in 99 per cent. of the cases.

Among the 36,142 wage-earners engaged in gold and silver mining, 2 per cent. were paid less than $1.75; 8 per cent. were paid less than $2.50; and 67 per cent. were paid less than $3.50. There is thus a marked variation in the wage rates paid for mining in the different mining industries. The fairest comparison, if a comparison between wages in manufacturing and wages in mining industries is to be made, must recognize the geographical wage variations. Most of the wages from manufacturing industries relate to the North Atlantic and the North Central States. An examination of the figures for mining shows that the wage rates paid in these states are considerably lower than the wage rates in the Western States, where smelting and refining are the chief mining industries. Two fifths of the wage-earners employed in mines and quarries in the United States were in the North Atlantic States; a third were in the North Central States; and only an eighth were in the Western States. The great bulk of the mining work is therefore carried on in the North Central States.

The wages in the North Atlantic Division relate to coal mining, chiefly. They are somewhat lower than the wages reported for the North Central States, as appears in the following comparison:

TABLE IX

Wage Rate Per Day Less Than	North Atlantic Division	North Central Division
$1.75	20 per Cent.	6 Per Cent.
$2.00	36 Per Cent.	19 Per Cent.
$2.50	69 Per Cent.	63 Per Cent.
$3.50	95 Per Cent.	96 Per Cent.

Although these figures for mines and quarries are so far out of date that no well-marked conclusions may be based on them, they indicate that in the mining industry wage rates are comparatively similar to the rates in the manufacturing industries in like geographical sections.

XI. Service Incomes in Organized Industry

The figures cited in this chapter are far from conclusive. They are, in many cases, woefully incomplete. They cover only a part of the industries in which men and women are gainfully employed. The most surprising thing about the figures is their uniformity. Collected by different organizations, and under essentially varied conditions, the product of general state and federal inquiry and of specific individual wage investigations, the figures agree marvelously. Wages in the west are generally higher than wages in the east.[53] Throughout the country lying east of the Rocky Mountains, and in the industrial sections lying north of the Mason and Dixon Line, the facts appear to be unquestionable and unquestioned. Subsequent investigation will reveal minor variations, but the large wage facts will still stand as they do in these summaries.

A comparatively small percentage of the persons gainfully employed in modern organized industry are on a salary basis. Of those so classified, the great proportion are foremen, assistant superintendents and managers, and clerks, whose salaries, for the most part, differ little from the salaries of the better-paid wage-earners. A small proportion of them are paid more than $1,000 per year, and a vanishing number receive more than $1,500. The vast majority of those gainfully employed in organized industry, certainly 95 per cent., are paid a wage or its equivalent. The figures showing that wage appear in the following brief summary:

Table X

Compensation Rates for Males in Certain Groups of Occupations

	Per Cent. of Males Receiving Wage Rates per Year of Less Than					
	$250	$500	$750	$1,000	$1,250	$1,500
Bell Telephone System Leading Occupations (1908)	.....	5	40	80	.....	99
Mercantile establishments, California (1911–12)	.....	10	30	55	.....	.....
Iron and steel, United States (1910)	.....	10	60	85	.....	97
Textiles (1910–12)	.....	60	90	95	.....	.....
Miscellaneous (1910–11)	.....	30	60	90	.....	98
Manufacturing:						
Massachusetts (1910)	1	34	71	91	.....	.....
New Jersey (1911)	2	36	71	89	.....	.....
Kansas (1909)	2	26	70	91	.....	.....
Wisconsin (1909)	2	32	77	94	.....	99
Oklahoma (1911)	1	17	68	90	.....	.....
California (1911)	2	7	30	63	.....	.....
Census (1905)	8	47	79	94	.....	.....

The conclusions from these figures are inevitable. The great majority (almost nine tenths) of the adult males receive wage rates of $1,000 per year, or less. An equal proportion of females receive less than $750.

[53] "Wages in the United States," *op. cit.*, Chapter 8.

TABLE XI

COMPENSATION RATES FOR FEMALES IN CERTAIN GROUPS OF OCCUPATIONS

	Per Cent. of Females Receiving Wage Rates Per Year of Less Than			
	$250	$500	$750	$1,000
Mercantile establishments:				
California cities (1911–12):				
Retail	10	35	75	95
Wholesale	3	20	60	90
Baltimore stores, Saleswomen (1909)	54	95	99	.....
Washington stores, Saleswomen (1912)	25	87	.....	.....
Textile manufacturing (1911–12)	15	85	98	.....
Miscellaneous (1909–11)	25	90	98	.....
Manufacturing:				
Massachusetts (1910)	7	79	99	.....
New Jersey (1911)	17	86	98	99
Kansas (1909)	25	88	98	100
Wisconsin (1909)	32	93	98	99
Oklahoma (1911)	8	84	97	99
California (1911)	9	40	82	97
Census (1905)	34	92	99	.....

The wage rates of four fifths of the males fall below $750; a third below $500. Among female wage-earners the scale is much lower. Three quarters or four fifths are paid less than $500 per year. These statements make no allowance for unemployment, which is a constant irreducible factor. Unemployment due to lack of work alone is generally met with.[54] Add to this the unemployment produced by sickness, accidents and other personal causes, and the proportion is still higher.

These facts make one thing impossible. Hereafter no one need discourse at length on the theme of the spendthrift laborer and the ensuing hardship of his family. The wage scale of the country is so adjusted at the present time that the vast majority of the recipients of wages and salaries are paid a wage which, when compared with the cost of a decent or fair standard of living, appears in many instances insufficient, and in many others, barely adequate, to procure the decencies of life. The time may come when the laborer's condition is due to his extravagance and lack of foresight. For the present, the scale of service income offers an explanation so telling that it would require hardihood of unusual type to saddle even a major portion of the blame for the situation on the individual worker.

[54] An idea of the extent of unemployment may be gained from the reports of the New Jersey and the Massachusetts Labor Bureaus, showing the number of days worked in the various industries. See Bureau of Statistics of New Jersey, 1913, Paterson, 1914, pp. 125–128. Also Statistics of Manufactures for 1911, Bureau of Statistics for Massachusetts, Public Document 36, Boston, 1913, p. 137.

FAMILIES OF AMERICAN MEN OF SCIENCE

By J. McKEEN CATTELL

IN a series of articles entitled "A Statistical Study of American Men of Science," printed in *Science* in 1906 and 1910 and as an appendix to "The Biographical Directory of American Men of Science," methods were explained by which the thousand leading scientific men of the United States had been selected and arranged in the order of the merit of their work. Studies were made of the measurement of scientific performance, of the origin and distribution of scientific men, and of the changes which occurred during an interval of several years. Data have now been gathered in regard to the families of the men of science previously selected. In our present state of ignorance a statistical study of any homogeneous and objectively chosen group should be of value, both as a contribution to psychological and vital statistics in general and for comparison with other groups which may be similarly studied. Scientific men form a desirable group for such study as, on the one hand, they may be assumed to be willing and competent to supply the information and, on the other hand, knowledge concerning the conditions favorable to scientific performance may have important practical applications.

Of one thousand one hundred and fifty-four scientific men from whom information in regard to their families was requested 1,036 replied and 118 did not. Of the replies 16 were blank, sometimes accompanied by the explanation that the information was not readily attainable or the like, 7 were to the effect that the information would be sent later or the like, 13 were received too late, 25 were very imperfect, 975 were usable and in most cases complete. This is an unusually full reply to a questionnaire. For example, in answer to an inquiry in regard to noteworthy relatives addressed to 467 fellows of the Royal Society, Sir Francis Galton received 207 useful replies, and the completely available returns "scarcely exceeded 100." In such cases it is desirable that returns should be complete in order to avoid the selection of a special class. Thus, when people are asked whether they have noteworthy relatives, those having them are more likely to reply than others, and the percentage of positive replies may give no definite information in regard to the frequency. In the present case it appears, from examination of the names of the ten per cent. who failed to reply, that there was no group that would affect appreciably the result of the inquiry.

I. Origin, Heredity and Performance

In the previous articles statistics were given in regard to the birthplace of the scientific men, and data are now at hand in regard to the nationality and race of their parents. Of the thousand scientific men first selected 126 were born abroad—34 in Canada, 38 in Great Britain and 19 in Germany. Table I. gives the nationality of the parents of 917 leading scientific men. Six hundred and twenty-eight, or more than two thirds, have both parents of native American (United States) birth, 23 others have an American father and 42 an American mother, foreign men having American women more frequently than the reverse. In 165 cases both parents are foreign born and of the same nationality. Including Americans there are 124 marriages in which the nationality of the parents was mixed, but they were largely British. The American-born parents are mainly of British and New England descent; of foreign-born parents, 137 fathers and an equal number of mothers are English, Scotch, Irish or Canadian. Germany contributes 77 fathers and 66 mothers. Other nations contribute in all 51 fathers and 44 mothers—fairly equally distributed among Norwegians, Swedes, Russians, Dutch, French and Swiss, with several from Denmark, Italy and Japan. The parents of American men of science are thus predominantly British-American, with an admixture of nearly 8 per cent. of Germans and about 5 per cent. from other nationalities.

Table I. Nationality of the Parents of American Men of Science

	Both Parents	Father Only	Mother Only	Total Families
American..	628	23	42	660.5
English...	48	36	28	80
Scotch....	9	13	15	23
Irish.....	4	10	12	15
Canadian..	14	3	7	19
German...	54	23	12	71.5
Norwegian.	6	0	0	6
Swedish...	6	0	0	6
Danish....	1	2	1	2.5
Russian...	6	0	0	6
Dutch.....	3	3	5	7
French....	6	6	2	10
Swiss.....	6	4	0	8
Italian....	0	1	0	0.5
Japanese..	2	0	0	2
Total...	793	124	124	917

Twelve and six tenths per cent. of our leading scientific men are foreign born, 12.6 per cent. are native born of foreign-born parents, and 7.1 per cent. have one foreign-born parent. In the general population of the United States 14 per cent. of the people are foreign born, 13.5 have both parents foreign born and 6.7 have one parent foreign-born. The foreign born and those of foreign-born parentage thus contribute less, but only slightly less, than the native population to scientific productivity. There is a great difference in the different nationalities. Those born in Great Britain contribute 1.2 per cent to the population and 3.4 per cent. to our scientific men; Germany contributes 2.7 per cent. to the population and 1.9 per cent. to the scientific men; Russia 1.7 to the population and 0.6 to the scientific men; Italy 1.5 to

the population and 0.1 to the scientific men. These differences are not, however, necessarily due to any racial superiority of the British and Germans. Men have been called from these countries to scientific positions here or have come to seek them, and in general a larger proportion of their immigrants have been from the educated classes. In my own science men so distinguished as Professor Münsterberg from Germany and Professor Titchener from England have accepted chairs of psychology in our universities. It is most unfortunate for us that this movement appears to have ceased. Between 1903 and 1910 only one scientific man of high distinction was called to this country, whereas nine leading scientific men returned to their native countries.

We could and should see to it that the foreigners coming to the United States contribute their share of men of performance. From the point of view of national selfishness nothing could be more profitable than to add to the community as many foreign men of distinction as would come for five or ten thousand dollars a year, and as many young men of promise as would come for one or two thousand dollars a year. Such men are already selected and their education is paid for. We have paid for the education of some 150,000 physicians to obtain at most 1,000 who are competent to advance medical science. The services of this thousand are probably worth as much as those of all the others combined, so if we divide equally the cost of bringing up and educating these physicians, the cost of a man competent to advance science is perhaps $500,000 and his value is far greater. Such men we can obtain from abroad free of cost beyond the payment for their living, which must be paid equally to those who are educated and selected at our own expense. Not only the men themselves, but their descendants also are assets to the country of incalculable value. From the point of view of the world at large, it is probably an advantage to bring men of distinction and of promise to this country, as this tends to promote friendly international relations and good-will, and because, the wealth being greater here and the competition less, we should be able to give better opportunity to the men. The war has placed on us great responsibility; we should provide for those debarred from advancing science, scholarship and art at home. If Great Britain can afford to cast ten billion dollars into the abyss, we are able to invest an equal sum to advance the arts of civilization.

While it is comparatively easy to determine the nationality of scientific men and of their parents, it is almost impossible to determine their race. Indeed, a consideration of the subject leads to a realization of the complexity of the racial descent of the peoples forming the nations of western Europe and America. There are 13.5 families stated to be Jews. Of 71.5 German families, 8 are Jews; of 6 Russian families, 5 are Jews; among 660.5 native American families, there is only one Jewish parent. There may be some unrecorded cases; the

number of native-born scientific men of Jewish family is smaller than might have been anticipated. Two families are Japanese; none is known to be of Negro or of North American Indian descent.

The scientific men have been divided into four groups in accordance with the merit of their performance. These are: I. those among the leading hundred of our scientific men; II. those among the second and and third hundreds; III. those below this rank in the thousand; and IV. those who in the second arrangement fell below the thousand. As shown in the previous paper, the first three groups cover about equal ranges of merit, and this also holds in a general way for the fourth group. In Table II. is given the nationality of the parents of the scientific men in accordance with these grades. Those of American parentage are of average standing; those of British parentage are below and those of German parentage are above the average. Those of other nationalities are slightly above the average. Among the leading hundred men of science seven are of Jewish family. The Jewish race thus appears to show superior intellectual ability. The differences in the other nationalities and races are so small as to indicate practical equality. The slight superiority of the Germans is due to several men who have come to this country to fill scientific positions, half of whom are of Jewish descent.

TABLE II. THE PERCENTAGE OF THE SCIENTIFIC MEN IN EACH OF FOUR GRADES ACCORDING TO THE NATIONALITY OF THEIR PARENTS

	No.	Percentage of Each Grade			
		I	II	III	IV
American.	652.5	7.7	18.3	57.9	16.0
British...	137	6.6	17.9	56.9	18.7
German..	73.5	10.2	20.4	57.1	12.2
Others....	48	8.3	20.8	56.3	14.6
Total....	911	71	169	525	146
Per cent.		7.8	18.6	57.6	16.0

TABLE III. THE OCCUPATIONS OF THE FATHERS OF THE SCIENTIFIC MEN

	No.	Per Cent.	Percentage of Each Grade.			
			I	II	III	IV
Professions.....	381	43.0	8.9	18.4	57.5	15.2
Clergymen....	89	10.1	5.6	19.1	60.7	14.6
Physicians....	66	7.5	9.1	18.2	50.9	22.7
Lawyers.....	58	6.6	10.3	24.2	51.7	13.8
Teachers.....	74	8.3	10.8	18.9	59.5	10.8
Others.....	94	10.6	9.6	13.8	61.7	14.9
Agriculture.....	188	21.2	3.7	20.7	56.4	19.2
Manuf. and trade	316	35.7	7.9	17.4	61.1	13.6
Total.....	885		7.5	18.5	58.5	15.5

The occupations of the fathers of 885 scientific men are given in Table III. Forty-three per cent. belong to the professional classes; 21.2 per cent. to the agricultural classes and 35.7 per cent. to the

manufacturing and business classes. In the United States in 1850, 3.1 per cent. of white men having occupations were in the professions; 44.1 were engaged in agriculture, and 34.1 in trade, transportation, manufacturing and mechanical pursuits. The professional classes have thus contributed in proportion to their numbers about fourteen times as many scientific men as the others, the agricultural classes only half as many as the manufacturing and trading classes. The farm not only produces relatively fewer scientific men, but a smaller proportion of them are of high distinction and a larger proportion are in the lowest group. This traverses a common belief, as voiced, for example, by Dr. Charles W. Eliot, when he writes:

> The country breeding gives a vigor and an endurance which in the long run outweigh all city advantages, and enable the well-endowed country boys to outstrip their city-bred competitors.[1]

The writer showed, however, in the previous paper that in proportion to their population cities have produced twice as many scientific men as the country.

The four professions of divinity, medicine, law and teaching, with a fifth group composed of the remaining professions—engineering, fine arts, journalism, the government service, etc.—contribute numbers of scientific men not far from equal. According to the census of 1850, the numbers in the four learned professions were: Clergymen, 26,842; lawyers, 23,939; physicians, 40,765; men teachers, 30,530. For each thousand of their members, they contributed scientific men as follows:

Clergymen	3.3
Lawyers	2.5
Teachers	2.4
Physicians	1.6

Clergymen, therefore, have the best record, and physicians the worst. Yet at that period there was supposed to be a conflict between science and theology, and the work of the physician is, or should be, allied to, if not identical with, that of the man of science. But in the middle of the last century the clergymen were likely to be better educated and more closely identified with the colleges than the physicians. The lawyers and the teachers were equally productive, but college professors —of whom there were only 943 in 1850—are far before any other class. The group of "other professions" is too ill defined to permit statistical treatment. In the census of 1850, mechanics who ran engines were called engineers and included among the professions. It will be noted from the table that lawyers and teachers have contributed the largest

[1] "Family Stocks in a Democracy," American Contributions to Civilization, 1898.

percentage of scientific men of high distinction, but the differences are not so large as to be significant.

As it is much easier to determine nationality than race, so occupation can be stated more readily than social position. It would be desirable to know the social connections and incomes of the fathers of scientific men at the period when their sons were educated, but such information is not at hand. Men in the same profession have very different social environments; in manufacturing and trade a man may be an artisan or a multi-millionaire. It is, however, clear that a majority of scientific men come from the so-called middle and upper classes. Not very far from half of them are supplied by the professional classes, forming about one thirtieth of the population, and undoubtedly they tend to be sons of the more successful professional men. Under manufacturing and trade all sorts of occupations are included, but only a small part of the fathers belong to the class of artisans and still fewer to the class of clerks. Most of them own their own business, which may be anything from a small shop in a university town[2] to the control of a railway system. Not a single scientific man is recorded as coming from the class engaged in domestic service, nor is any known to be the son of a day laborer, even of the higher grades. Agriculture includes agricultural laborers, but the fathers of the scientific men usually owned their own farms, and were probably in the main the farmers of the better class with relatives among professional men. Our farming population belongs chiefly to a yeoman class, not to a peasant class, such as forms nine tenths of the population of Russia.

The earlier studies of scientific men made by De Candolle and Galton and the groups treated by Odin and Ellis yield results in regard to the origin of men of performance comparable with those here given. De Candolle[3] found that of 100 foreign associates of the Paris Academy of Sciences, 41 came from noble and wealthy families, 52 from the middle class and 7 from the working class. Galton[4] found that of 96 contemporary leading men of science none came from the artisan and peasant classes. Odin[5] found that of 823 French men of letters, 65 per cent. came from the nobility and governing classes, 23 per cent. from the professions, 12 per cent. from the commercial and middle classes and 16 per cent. from the lower classes. Ellis[6] found that of 829

[2] A notable case is of three brothers who have attained scientific distinction. They obviously had inherited ability, but the opportunity to exhibit it in scientific research was probably due to the fact that their father's shop was in a university town.

[3] "Histoire des Sciences et des Savants depuis deux Siècles," Genève, 1873.

[4] "English Men of Science," London, 1874; New York, 1875.

[5] "Genèse des Grands Hommes," Paris et Lausanne, 1895. An excellent account of Odin's researches is given in Lester F. Ward's "Applied Sociology," Boston and New York, 1906.

[6] "A Study of British Genius," London, 1904.

British men of genius 18.5 per cent. came from the nobility and upper classes, 41.3 per cent. from the professions, 31.2 from the manufacturing and commercial classes, 6 per cent. from the yeomen and farmers and 2.5 from the artisan and laboring classes.

The working classes outnumber the nobility a hundredfold, but produce only one quarter as many men of performance. If the working classes have equal ability and if they had been given equal opportunity, instead of a hundred scientific men of the rank of the foreign associates of the Paris Academy there would have been forty thousand. It may be that the peasant and artisan classes in European countries are separated from the upper classes by an inferior heredity; but that is scarcely the case in America. Five or ten generations back most of us have ancestors of nearly the same average physical, intellectual and social condition; any selection for ability within this short period must be slight and transient.

It is evident that what a man can do depends on his congenital equipment. How far what he does do depends on his environment and how far on his congenital equipment, or how far his congenital equipment depends on that of his parents and his family line of descent, we do not know.. Most sociological writers and some biologists are confused in their use of the concept of heredity. When there is discussion of the relative influence on performance of heredity and environment, by heredity there is sometimes understood the original constitution of the individual and sometimes his resemblance to parents and other relatives. It is conceivable that the original constitution of son and father might be exactly the same and yet the individual be so plastic to environment that under different conditions there would be but slight similarity between their performances. It is also conceivable that there might be no similarity between the original constitution of son and father, and yet the performance of each be determined by his original constitution almost without influence from environment. Under which of these extreme hypotheses would the current sociologist call heredity strong or weak? The word heredity should be reserved for resemblance due to a common germ plasm and some other word found for the constitution of the fertilized ovum or zygote; perhaps the best that can be done is to use this uncouth word. We can then discriminate between the two distinct questions: What is the resemblance between the zygotes of two brothers? How far does the zygote of an individual determine his performance as an adult?

The distinctions are of vast importance for the organization of society. If men of performance could only come from superior family lines, this would be a conclusive argument for a privileged class and for a hereditary aristocracy. If the congenital equipment of an individual should prescribe completely what he will accomplish in life, equality

of opportunity, education and social reform would be of no significance. Such an extreme position, though it is approached by men with so much authority as Sir Francis Galton, Professor Karl Pearson, Dr. F. A. Woods, Dr. C. B. Davenport and Professor E. L. Thorndike, is untenable. Equally extreme in the opposite direction is M. Odin's aphorism "Genius is in things not in men," or the not uncommon opinion that almost anything can be done with a child by training and education. It is a problem of degree and of circumstance, a scientific question that could probably be solved within a reasonable time, if as much intelligence and money were devoted to it as to one of the bureaus of the Department of Agriculture.

In the meanwhile we must do the best we can with the material at hand, even though the interpretation is in nearly all cases ambiguous. It is here shown that 43 per cent. of our leading scientific men have come from the professional classes. We may conclude that more than one half of our men of science come from the one per cent. of the population most favorably situated to produce them. The son of a successful professional man is fifty times as likely to become a leading scientific man as a boy taken at random from the community. My data also show that a boy born in Massachusetts or Connecticut has been fifty times as likely to become a scientific man as a boy born along the southeastern seaboard from Georgia to Louisiana. They further show that a boy is fifty times as likely to do scientific work as a girl. No negro in this country has hitherto accomplished scientific work of consequence. A boy from the professional classes in New England has a million chances to become a scientific leader as compared with one chance for a negro girl from the cotton-fields.

These great differences may properly be attributed in part to natural capacity and in part to opportunity. When it is asked how far the result is due to each of these factors, the question is in a sense ambiguous. It is like asking whether the extension of a spiral spring is due to the spring or to the force applied. Some springs can not be extended a foot by any force; no spring can be extended without force. The result depends on the relation between the constitution of the spring and the force applied. If the 174 babies born in Massachusetts and Connecticut who became leading scientific men had been exchanged with babies born in the south, it seems probable that few or none of them would have become scientific men. It may also be the case that few or none of the babies from the south transplanted to New England would have become scientific men, but it is probably true that a nearly equal number of scientific men would have been reared in New England. It is certain that there would not have been 174 leading scientific men from the extreme southern states and practically none from Massachusetts and Connecticut. If the stock of the southern states remains undiluted, it may, as social conditions change, produce even

more scientific men per thousand of its population than New England has hitherto produced. In the first list of the thousand leading scientific men, Massachusetts produced 109 and Connecticut 87 per million of their population. Of the younger men added to the list in the second arrangement under comparable conditions, Massachusetts produced 85 and Connecticut 57. The other North Atlantic states failed in like measure, while the central states show a gain—Michigan from 36 to 74, Minnesota from 23 to 59, etc. These changes must be attributed to an altered environment, not to an altered racial stock. Japan had no scientific men a generation ago and China has none now, but it may be that in a few years their contributions to science will rival ours.

A Darwin born in China in 1809 could not have become a Darwin, nor could a Lincoln born here on the same day have become a Lincoln had there been no civil war. If the two infants had been exchanged there would have been no Darwin in America and no Lincoln in England. Darwin was a member of a distinguished family line possessing high natural ability and the advantages of opportunity and wealth. Lincoln had no parental inheritance of ability or wealth, but he too had innate capacity and the opportunity of circumstance. If no infants had been born with the peculiar natural constitutions of Darwin and Lincoln, men like them could not have been made by any social institutions, but none the less the work they did might have been accomplished by others and perhaps their fame would have been allotted to others. There may have been in England other family lines equal in natural ability to the Darwins and in this country other individuals as well constituted as Lincoln, but undistinguished from lack of opportunity. It is still more probable that such conditions obtain in Russia and in China, in whose graveyards there may lie innumerable "mute inglorious" Miltons, Lincolns and Darwins.

The most exceptional ability may be suppressed by circumstances; but it can sometimes deal with them on equal or perhaps superior terms. Thus the writer has pointed out how widely distributed in race, age and performance are the most distinguished men who have lived.[7] When we turn from the most eminent men to those next in rank, we may doubt whether their natural ability has not been equaled by thousands who have not attained distinction. Among the two hundred most eminent men who have lived in the history of the world are: Napoleon III., Nero, Fox, Julian, Fénelon, Clive, Alberoni, Bentley and Gerson. It is quite conceivable that there are at present living in the United States hundreds or thousands of men having as great natural ability as these. There may be a hundred thousand men and women

[7] "A Statistical Study of Eminent Men," THE POPULAR SCIENCE MONTHLY, 1903.

having the natural and specific ability of the thousand in this country who have accomplished the best scientific work.

President A. Lawrence Lowell has remarked that we have a better chance of rearing eaglets from eagles' eggs placed under a hen than from hen's eggs placed in an eagle's nest. But it is equally true that we have a better chance of raising tame eaglets in a chicken coop than in an eyrie. The difference between a man uninterested in science and a scientific man is not that between a chicken and an eagle, but that between an untrained chicken and a trick cock. Some cockerels can be trained better than others, but there are innumerable cockerels that might be trained and are not.

The son of a scientific man may on the average have the inherited ability which would make him under equally favorable circumstances twice, or ten times, or a hundred times, as likely to do good scientific work as a boy taken at random from the community. The degree of advantage should be determined. It surely exists, and the children of scientific men should be numerous and well cared for. But we can do even more to increase the number of productive scientific men by proper selection from the whole community and by giving opportunity to those who are fit. Galton finds in the judges of England a notable proof of hereditary genius. It would be found to be much less in the judges of the United States. It could probably be shown by the same methods to be even stronger in the families conducting the leading publishing and banking houses of England and Germany. As I write, the death is announced of Sir William White, the distinguished naval engineer, chief constructor of the British navy, president of the British Association. If his father had been chief constructor of the navy, he would have been included among Galton's noteworthy families of fellows of the Royal Society. The fact that his father-in-law was chief constructor of the British navy throws, if only by way of illustration, a light on the situation in two directions.

On the one hand, the specific character of performance and degree of success are determined by family position and privilege as well as by physical heredity; on the other hand, marriage, chiefly determined by environment, is an important factor in maintaining family lines. The often-quoted cases of the Jukes and Edwards families are more largely due to environment and intermarriage within that environment than to the persistence of the traits of one individual through several generations. The recently published "Kallikak Family" by Dr. H. H. Goddard demonstrates once again the heredity of feeble-mindedness. It would, however, have been a stronger argument for the omnipotence of heredity if the original ancestor had left by a healthy mother illegitimate children who established prosperous lines of descent, and a child by a feeble-minded wife who left degenerate lines of descent. Two ex-

periments have been made on a large scale which seem fairly definite even though quantitative results can not at present be reached. The mulattoes may be assumed to have a heredity midway between negroes and whites, but their social environment is that of the negroes, and their performance corresponds with their social environment rather than with their heredity. Illegitimate children have perhaps a heredity as good as the average, but their performance falls far below the average. If performance were determined by heredity alone there might be expected to be among our thousand leading scientific men some forty mulattoes and some forty of illegitimate birth, whereas there is probably not one of either class.

At nearly the same time Agassiz came from abroad to Harvard and Brünnow to Michigan. We all know the list of distinguished naturalists trained under Agassiz—Brooks, Hyatt, Jordan, Lyman, Minot, Morse, Packard, Putnam, Scudder, Shaler, Verrill, Whitman, Wilder and many more, directly and indirectly. From Michigan have come, as is not so well known, one fourth of our most distinguished astronomers, including Abbe, Campbell, Comstock, Curtis, Doolittle, Hall, Hussey, Klotz, Leuschner, Payne, Schaeberle, Watson and Woodward. Certainly the coming of Agassiz and Brünnow was the real cause of greatly increased scientific productivity in America. Some, but not all, of those who worked under Agassiz would have become naturalists apart from his influence. The astronomers from Michigan must in the main be attributed to their environment. The men had the necessary ability, but if Brünnow had not gone to Michigan, they would not have become astronomers; if they had gone to the University of Pennsylvania, they would have been more likely to have become physicians than astronomers; if they had not gone to a university they would not have become scientific men.

It is certainly satisfactory if we can attribute the inferiority of scientific performance in America as compared with Germany, France and Great Britain to lack of opportunity rather than to lesser racial ability. In Germany scientific research has been made by the university rather than the reverse. In Great Britain also the universities have been potent, and, in addition, its leisure class has contributed greatly. Here prior to 1876 we had no university in which research work was adequately encouraged, and we have had no amateurs comparable to those of Great Britain. Professor Pickering found[8] that of the 87 scientific men who were members of at least two foreign academies, 6 were Americans as compared with 17 from Prussia, 13 from England and 12 from France. In so far as our scientific production is so measured, the reference is to a generation ago, when our universities were only beginning to develop and research work was only beginning to be appreciated. But it is a striking fact that of the six distinguished

[8] THE POPULAR SCIENCE MONTHLY, October, 1908, and January, 1909.

Americans, three are astronomers; and astronomy is the only science in which thirty years ago the facilities for research work in this country were equal to those of the leading European nations. Of the remaining three, two have not been engaged in teaching, and the third has been practically freed from teaching for his research work. We may hope that when conditions become as favorable for other sciences as they have been for astronomy, the United States will assume leadership in scientific productivity.

In order to answer questions such as the extent to which the scientific work accomplished in America is due to native endowment, whether such endowment is general or specific, how far it occurs in family lines, what part of those endowed are able to prove their ability, the influence of education and example, the effects of opportunity, encouragement and rewards, it is necessary to make a study of individual cases. A large mass of material is at hand concerning the relatives of scientific men who have shown scientific productivity or have attained distinction, but these data are not in order for publication and should be supplemented by answers to many enquiries. In the meanwhile the writer may say that it is his opinion that while we should welcome and support a eugenic movement tending to limit the birth of feeble-minded and defective children and encouraging the birth of those that are well endowed, it appears that under the existing conditions of knowledge, law and sentiment, we can probably accomplish more for science, civilization and racial advance by selecting from the thirty million childen of the country those having superior natural ability and character, by training them and giving them opportunity to do the work for which they are fit. We waste the mineral resources of the country and the fertility of the soil, but our most scandalous waste is of our children, most of all of those who might become men and women of performance and of genius.

Eugenics may become the most important of all applied sciences, but at present its scientific foundations must be laid by the study of comparative genetics, on the one side, and the study of human conduct, on the other. There is more immediate prospect of improving our civilization than our germ plasm. It is easier to decrease or eliminate typhoid fever by hygienic measures than to attain racial immunity, although this is not equally the case for tuberculosis and still less for cancer. We can increase to any desired extent from the existing population by proper selection and training the number of scientific workers in the United States. The number capable of exhibiting genius is limited, but many of them are lost through lack of opportunity. It is our business, it should be our principal business, to improve our civilization by giving opportunity to those who are fit, while at the same time investigating the conditions which will give us a better race.

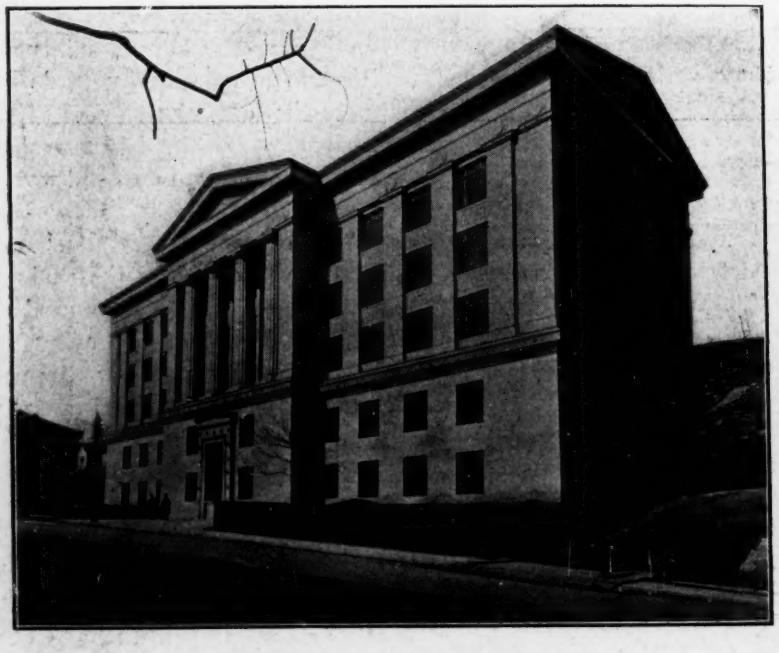
(*To be continued*)

THE PROGRESS OF SCIENCE

THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH

EIGHT years ago Robert Kennedy Duncan, then of the University of Kansas, proposed, and later carried into effect, a plan for industrial fellowships in chemistry which embodies a new method of education and research. According to this plan, an industrial firm established temporary research fellowships at a university, and the students appointed to them by the university carry on work, which may be of value to the firm, under the auspices of the professors. Patents or improvements which result belong to the firm, but the scientific work may later be published for the benefit of science, and the students may have some share in profits that result and an opportunity of regular employment by the company. This plan was continued by Dr. Duncan at the University of Pittsburgh, and resulted in the Mellon Institute of Industrial Research recently dedicated.

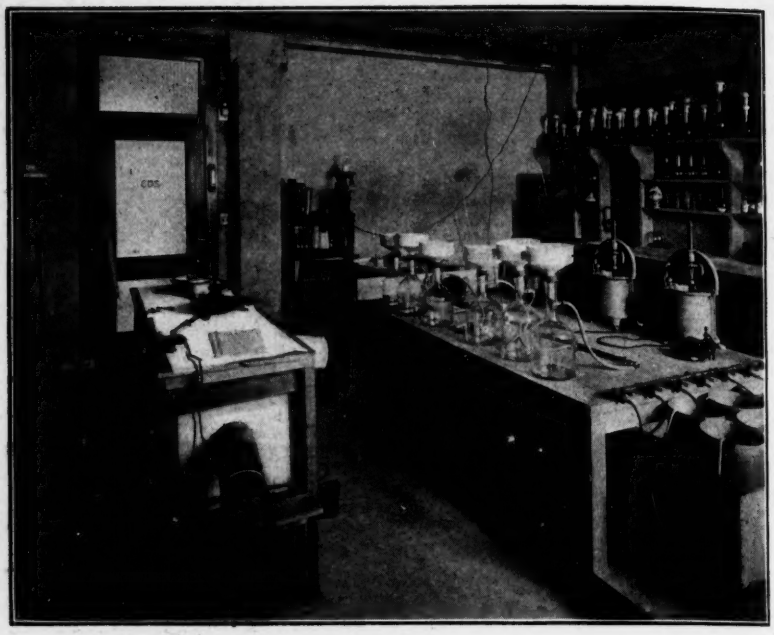
Dr. Duncan died while the building was in course of construction, but had the satisfaction of seeing this method of cooperation between the university and research, on the one side, and industrial establishments and practical utility, on the other, placed on a permanent basis. It has been extended beyond the institution and the science for which it was inaugurated. Thus there is just announced an extensive plan inaugurating business fellowships at New York University with the cooperation of a number of leading commercial houses.



THE NEW BUILDING OF THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH AND SCHOOL OF SPECIFIC INDUSTRIES OF THE UNIVERSITY OF PITTSBURGH.

THE OFFICE OF THE DIRECTOR OF THE MELLON INSTITUTE, DR. RAYMOND F. BACON.

THE LIBRARY OF THE MELLON INSTITUTE.



A VIEW IN ONE OF THE THIRTY-EIGHT RESEARCH LABORATORIES which have been finished and assigned in the New Building of the Mellon Institute.

The Mellon Institute has its own endowment and board of trustees, but is educationally an integral part of the University of Pittsburgh. It is the gift of A. W. Mellon and R. B. Mellon and has been erected at a cost of $350,000. The donors have also provided $40,000 a year for five years for maintenance. At the dedicatory exercises Dr. W. J. Holland, director of the Carnegie Museum and formerly chancellor of the university, said:

In a certain sense, Mr. Chancellor, this building is a memorial to Robert Kennedy Duncan. On one side of the entrance is a bronze slab inscribed with the name of Thomas Mellon; on the other side of the entrance is a bronze slab inscribed with the name of Robert Kennedy Duncan. But, Mr. Chancellor, this splendid edifice erected upon the campus of our university is more than a cenotaph. It not merely commemorates the names and careers of those of whom I have spoken, but it is intended to serve as the seat of advanced inquiries along scientific lines, which will tend to the promotion not merely of intellectual culture, but of industrial success, and that not merely in this great "workshop of the world," where it is located, but throughout the land. In creating this institution our dear friends have been actuated by a high and intelligent purpose. Large experience in great industrial enterprises has taught them the importance of chemistry and physics in their application to the industrial arts, and they feel that, wonderful as has been the progress made within the last century, there are untold mysteries in nature which have not yet been revealed, but which, if uncovered, are capable of being used for the welfare of mankind. And so they have created and are to-day placing in the custody of you, gentlemen of the board of trustees, this institution, which is capable of becoming, when wisely and intelligently administered, a mighty implement for the advancement of human welfare.

The new building of the Mellon Institute, as shown in the accompanying illustration, is a five-story and attic building. The basement contains seven rooms: the main storeroom, the boiler room, the electric furnace room, a

heavy apparatus room, a room equipped for low-temperature work, the machine shop and a kitchen. On the first, the main floor, are located the general office, the directors' suite, the office of the editorial department, the library, the office and laboratory of the assistant directors, the assembly hall, a special apparatus room and a dark-room laboratory. The second and third floors each contain ten large research laboratories and nine small ones; the fourth floor, which is not finished, will contain an identical number of laboratories as soon as the growth of the institute warrants its completion. At the present time twenty-three fellowships are in operation and forty research chemists are engaged in a study of the variety of industrial problems under investigation at the institute.

ATOMISM IN MODERN PHYSICS

In an address at the spring meeting of the National Academy of Sciences, Dr. R. A. Millikan, of the University of Chicago, reviewed the discoveries of the newer physics. In abstract he said:

Atomism in modern physics begins with Dalton's discovery in 1803 of exact multiple relationships between the combining powers of the elements. Out of this discovery grew the whole of modern chemistry. The second tremendously important step was taken in 1815 when Prout pointed out that the atomic weights of the lighter elements appeared to be exact multiples of that of hydrogen, thus suggesting that hydrogen was itself the primordial element. The periodic table of Mendeleef added support to such a point of view, and Moseley's recent brilliant discovery through the study of X-ray spectra of a new series of multiple relationships, represented by a consecutive series of atomic numbers from 13 up to 79 with every number except three corresponding to a known element, is another most significant bit of evidence. When we add to this three other facts, namely, (1) that each member of a radioactive family, like the uranium family, has been definitely shown to be produced from its immediate ancestor by the loss by that ancestor of one atom of helium (which is almost equal in weight to four atoms of hydrogen), (2) that in an atomic weight table the differences between the weights of adjacent elements are in almost every case exact multiples of the weight of the hydrogen atom, the characteristic helium difference 4 appearing with extraordinary frequency, and (3) the fact that the introduction of the concept of electromagnetic mass, and the consequent discovery of the inconstancy of mass, open several ways of explaining the slight departures in the exactness of the multiple relations between atomic weights pointed out by Prout, it will be evident that modern science may well feel fairly confident that it has indeed found in hydrogen the primordial atom which enters into the structure of all the elements. All this is merely a very modern verification of very ancient points of view.

But modern physics has recently taken a more significant and more fundamental step than this, for it has looked inside the atom with the aid of X-rays and other ionizing agents, and has there come upon electrically charged bodies, whose inertia or mass is wholly accounted for, at least in the case of the negative elements, by their charges This discovery marks the fusing into one another of two streams of physical investigation, namely, the molecular stream and the electrical stream. A necessary condition for the justification of this last step was the bringing forward of indubitable proof that the thing which has heretofore been called electricity is after all, contrary to Maxwell's view, a definite material substance in the sense that it exists in every charge in the form of discrete elements; in other words, that it too like matter is atomic or granular in structure. Such proof was found in the discovery in the oil drop experiments of even more exact multiple relationships between all the possible

charges which can be put on a given body than Dalton had ever discovered between combining powers or Prout between atomic weights or Moseley between X-ray frequencies. The greatest common divisor of this series of charges is then the ultimate unit or atom of electricity which has been named the "electron." New evidence that it is indeed a universal and invariable natural constant will be brought forward and a new determination of its value will be presented.

It is obvious that as soon as we could assert that these electrons are found in the hydrogen atom it was necessary to suppose that a single hydrogen atom contains at least two such electrons, one positive and one negative, and as a matter of fact the evidence is now strong that it consists of exactly two. This twentieth century has then discovered for the first time a new subatomic world of electrons, the constituents of atoms.

All this is definite and probably permanent. But atomic conceptions in more or less vague form have also begun to invade the one remaining field of physical investigation, namely, the field of ethereal radiations. The most significant of recently discovered facts in the domain of radiant energy are these:

(1) Ethereal radiations when absorbed by matter, if they are of high enough frequency, will detach one and only one electron from a single atom. (2) The energy transferred to this electron from the ether wave is independent of the intensity of the incident radiation. (3) It is also independent of the kind of matter from which the electron is taken, but (4) it is exactly proportional to the frequency of the ether wave which detaches it.

These facts are stated in an equation set up tentatively by Einstein in 1905, and arrived at by him from the standpoint of a modified corpuscular theory of radiation. New proofs of the exactness of Einstein's equation will be presented and the evidence for and against Einstein's conception will be discussed. Whether the conception ultimately stands or falls, it appears probable, at any rate, that an equation has been obtained which is to be of no less importance in future physics than Maxwell's equation of the electro-magnetic field, and which seems destined to unlock for the physicists of the future the doors to the understanding of the relations existing between matter and radiant energy.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Frederick Winslow Taylor, of Philadelphia, past president of the Society of Mechanical Engineers, known for his inauguration of methods of "scientific management"; of Dr. Edith J. Claypole, research associate in pathology in the University of California; of Dr. A. A. W. Hubrecht, professor of embryology in the University of Utrecht; of Professor Stanislaus von Prowasek, head of the zoological department of the Hamburg Institute for Tropic Diseases; of Sir George Turner, distinguished for his work on the rinderpest and on leprosy, from leprosy, contracted during research work to discover a cure for the disease, and of Lady Huggins, widow of Sir William Huggins, the distinguished astronomer, and known for her scientific work.

MISS DAVY, niece of Sir Humphry Davy, has presented to the Royal Institution, London, a bust of the great chemist executed by Samuel Joseph in 1822.

THE Royal Astronomical Society has by a vote of 59 to 3 passed a resolution approving of the admission of women as fellows and associates of the society, and requesting the council to take all necessary steps to render their election possible.